Engineering Library

"THE ENGINEER," AUGUST 31, 1928.

SEP 13 1928

With METALLURGICAL SUPPLEMENT.

The Engineer.

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VOL. CXLVI.—No. 3790] LONDON: FRIDAY EVENING, AUGUST 31, 1928 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, invites TENDERS:—
SCHEDULE 1.—MACHINE SURFACE GRINDING, VERTICAL SPINDLE TABLE 96in.
LATHE AXLE JOURNAL RETURNING, HYDRAULIC LOCO. WHEEL PRESS.
SCHEDULE 2.—MOTOR TOWER WAGON, 5ft. 6in. gauge.
SCHEDULE 3.—ARTICULATED CARRIAGE UNDERFRAMES and BOGIES.
SCHEDULE 4.—RADIAL GATES for CANAL REGULATORS.
Tenders due on the 21st September, 1928, for No. 1, on the 25th September, 1928, for No. 2, on the 28th September, 1928, for No. 3, and on the 7th November, 1928, for No. 4.
Forms of Tender obtainable from the above at a fee (which will not be returned) of 5s. for each Schedule. 9417

Wanted at Once (Temporarily), TWO ENGINEERING ASSISTANTS, capable preparing detail drawings Reinforced Concrete Work and Steel Structures. Preference ex-Service men. Salary £140 per annum plus bonus (total emoluments £214 p.a.)
Apply, the SECRETARY, Air Ministry, Adastral House, Kingsway, W.C. 2. 9373

Applications are Invited for the POST of PROFESSOR OF MECHANICAL ENGINEERING, BENGAL ENGINEERING COLLEGE, SIBPUR, BENGAL.
Candidates must be not less than 30 nor more than 40 years of age. They must hold a good Degree in Mechanical Science Tripos, Cambridge, or in Mechanical Engineering from Glasgow, London, Manchester, Birmingham, or Dublin University, have had adequate experience in Mechanical Engineering Workshops of firm of repute, and be Associate Members of the Institution of Mechanical Engineers. Preference will be given to candidates who have had some University teaching experience.
Salary Rs. 700 a month, rising by annual increments of Rs. 50 a month to Rs. 900. In addition, overseas pay of £25 a month will be granted to an officer of non-asiatic domicile. Appointment on agreement for five years in first instance, with possibility of extension. Free first-class passage to India. Provident Fund. Free unfurnished quarters, subject to payment of municipal taxes. Strict medical examination.
Selected candidate will be required to join the appointment by the middle of November, 1928, or as soon as possible after that date.
Further particulars and forms of application may be obtained upon request by postcard to the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Department, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications, 19th September, 1928. 9369

Civil Engineer Required [by the GOVERNMENT of CEYLON for appointment as Irrigation Engineer for three years' service in the first instance. Salary £500, rising to £900 a year by annual increments of £40 (£600 a year on attaining 30 years of age). Free quarters and free passages provided. Candidates, unmarried, 26 to 31 years of age, must have passed examination to qualify for Associate Membership of the Institution of Civil Engineers or hold professional qualifications recognised by the Institution as exempting from Parts A and B of that examination, and have had at least three years' practical experience on Waterworks, Drainage, or Harbour and Dock Works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/732. 9416

Waterworks Engineers (2) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of 12 to 18 months' service, with possible extension. Salary £800, rising by annual increments of £40 to £920 a year; seniority allowance of £72 a year whilst on duty in the Colony. Free quarters, passages and liberal leave with full salary. Candidates, between 30 and 40 years of age, must possess a thorough knowledge of and experience in design and construction of Waterworks and in the investigation of water supplies in the Tropics and elsewhere. Must be Corporate Members of the Institution of Civil Engineers.—Apply at once by letter, stating age, qualifications and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/906. 9409

City of Cardiff Education COMMITTEE.
THE TECHNICAL COLLEGE.
Principal: CHARLES COLES, B.Sc. (Lond.).
DEPARTMENT OF ENGINEERING.
Head of Department: A. W. LOVERIDGE, B.Sc. (Eng.), A.R.C.Sc.
SESSION 1928-29.
(Commencing on Tuesday, 2nd October, 1928).
The following Courses have been arranged for Engineering Students:—
A Three Years' Course in Mechanical and Marine Engineering jointly with the University College of South Wales and Monmouthshire.
A Two Years' Course for Apprentices and others with facilities for practical experience in the Summer Term.
These Courses are suitable for Students preparing for Degrees in Engineering or for the Examinations of the Engineering Societies.
Special Courses are also arranged for Marine Engineers preparing for the Examinations of the Board of Trade.
OPEN SCHOLARSHIPS, covering tuition fees and maintenance grants of £40 per annum for three years, are offered for competition annually, and candidates for entry to the above Department are eligible to compete.
For further particulars of Full-time and Part-time Courses, Entrance Examination, Scholarships, Fees, &c., apply to the Principal. Application forms for Entrance Scholarship Examination, duly filled up, must be received before September 15th.
JOHN J. JACKSON, Director of Education, City Hall, Cardiff. 9327

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

The Metallurgist.
THE ENGINEER, 31 - 8 - 28.

The British Airship R 101. (P. 226)
THE ENGINEER, 31 - 8 - 28.

Flexibility of Plain Pipes—No. III. (P. 218)
(J. R. FINNIECOME.) THE ENGINEER, 31 - 8 - 28.

A 4000 B.H.P. Oil Engine. (P. 234)
THE ENGINEER, 31 - 8 - 28.

Rotary and Turbo Compressors No. II. (P. 233)
THE ENGINEER, 31 - 8 - 28.

Foreign Merchant Shipping. (P. 231)
THE ENGINEER, 31 - 8 - 28.

Apparatus and Methods for Measurement of the Hertzian Hardness—No. III. (P. 220)
(R. ESNAULT-PELTERIE.) THE ENGINEER, 31 - 8 - 28.

Enlarging the Burrator Reservoir. (P. 230)
THE ENGINEER, 31 - 8 - 28.

Telford Memorial in Scotland. (P. 225)
THE ENGINEER, 31 - 8 - 28.

Large Vacuum Paper Dryer. (P. 222)
THE ENGINEER, 31 - 8 - 28.

The FOURTH MACHINE TOOL & ENGINEERING EXHIBITION, OLYMPIA, SEPT. 5th-22nd.
"THE ENGINEER'S" STAND will be No. 39, ROW D, at which all our Friends will be welcome.

INDEX TO ADVERTISEMENTS, PAGE 71.

PUBLIC NOTICES

Northampton Polytechnic INSTITUTE, ST. JOHN-STREET, LONDON, E.C. 1.
FULL-TIME COURSES are provided as follows:—
ENGINEERING.
Courses extending four years in Civil, Mechanical, Electrical, Aeronautical, and Radio Engineering and including two summer periods in the works of industrial firms.
Matriculated students are prepared for internal degree examinations of London University.
OPHTHALMIC OPTICS.
A Course extending over two years and including preparation for the Fellowship Examinations of the British Optical Association and the Spectacle Makers' Company.
Fees from £18 per annum.—For prospectus and further information apply to
S. C. LAWS, M.A., M.Sc., Principal.
9406

Northampton Polytechnic INSTITUTE, ST. JOHN-STREET, LONDON, E.C. 1.
EVENING CLASSES IN ENGINEERING.
All branches of Civil, Mechanical, Electrical, Aeronautical, Automobile, and Radio Engineering.
APPLIED OPTICS.
Ophthalmic Optics, Optical Instrument Making, Optical Glass Working.
HOROLOGY. FURRIERY.
APPLIED CHEMISTRY.
Fuels, Electro-plating, Metallurgy, &c.
DOMESTIC AND ALLIED SUBJECTS.
COMMENCE SEPTEMBER 24th.
Enrolments during week commencing SEPTEMBER 17th.
Free prospectuses on application to
S. C. LAWS, M.A., M.Sc., Principal.
9405

PUBLIC NOTICES

Crystal Palace School OF PRACTICAL ENGINEERING.
President: J. W. WILSON, M.I.C.E., M.I.M.E., F.S.E.
Principal: MAURICE WILSON, M.I.C.E., F.S.E.
Vice-Principal: F. C. P. LAWRENCE, M.S.E., A.M.I. Struct. E.
WINTER TERM COMMENCES WEDNESDAY, SEPTEMBER 12th. 9383

University of Manchester.
PHYSICS DEPARTMENT.
Full particulars of the LECTURES and LABORATORY COURSES in PHYSICS, preparing for both the Ordinary and Honours Degrees, will be forwarded on application to the REGISTRAR. The SESSION COMMENCES on THURSDAY, OCTOBER 4th. 9275

Bombay, Baroda and Central INDIA RAILWAY CO.
The Directors are prepared to receive up to Noon, on Wednesday, 12th September, TENDERS for the SUPPLY of—
1. STEAM HAMMERS, STEEL PILING, &c.,
and up to Noon on Friday, 14th September, TENDERS for the SUPPLY of—
2. WHEELS and AXLES (Disc Centres),
3. GIRDER BRIDGES (30-metre Spans).
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each for No. 1, 2 and 3, which will not be returned.
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG, Secretary.
Offices, B.B. & C.I. Rly., The White Mansion, 91, Petty France, Westminster, S.W. 1.
28th August, 1928. 9372

PUBLIC NOTICES

The Polytechnic, 309, Regent-STREET, W. 1.
SCHOOL OF ENGINEERING.
President of the School: The Hon. Sir CHARLES PARSONS, O.M., K.C.B., M.A., LL.D., D.Sc., F.R.S., &c.
Head of Department: ALEX. B. HORNE, O.B.E., B.Sc. (Hons., Eng.), F.R.S. (Edin.), &c.
The DAY DEPARTMENT RE-OPENS on SEPTEMBER 18th, 1928. Entrance Examination commences 10th September, 1928, at 10 a.m.
Three-year DIPLOMA COURSES in
MECHANICAL ENGINEERING,
STRUCTURAL ENGINEERING,
ELECTRICAL ENGINEERING,
MOTOR CAR ENGINEERING.
Practice in the Laboratories, Drawing-office, Workshop, and Field.
Fee 21 Guineas per annum.
There are Three Entrance Scholarships in Structural Engineering.
The EVENING DEPARTMENT RE-OPENS on SEPTEMBER 24th, 1928. Students enrolled from September 17th, 1928.
The Day and Evening Courses are recognised for the Diplomas and Certificates issued by the Institutions of Mechanical and Electrical Engineers in conjunction with the Board of Education.
Full prospectus free on application to the DIRECTOR OF EDUCATION. 9322

The Polytechnic, 309, Regent-STREET, W. 1.
STUDENTSHIP EXAMINATION OF THE INSTITUTION OF MECHANICAL ENGINEERS.
PRELIMINARY EXAMINATION, INSTITUTION OF CIVIL ENGINEERS.
FINAL EXAMINATION, INSTITUTION OF ELECTRICAL ENGINEERS (Part 1).
Special Courses have been arranged for Students taking the above Examinations. The syllabus covers all the work in PURE MATHEMATICS, MECHANICS, PHYSICS, ENGLISH and FRENCH.
Fee for the Course £2 2s.
Prospectus free on application to the DIRECTOR OF EDUCATION. 9323

Borough Polytechnic Institute, BOROUGH-ROAD, LONDON, S.E. 1.
COMPLETE COURSES EXTENDING OVER FIVE YEARS OF EVENING WORK, LEADING TO THE ORDINARY AND HIGHER NATIONAL CERTIFICATES.
ENGINEERING SCIENCE.
PROPERTIES AND STRENGTH OF MATERIALS.
MACHINES AND HYDRAULICS.
HEAT ENGINES.
THEORY OF MACHINE AND MACHINE DESIGN.
STRUCTURAL ENGINEERING DRAWING.
STRUCTURAL STEELWORK DESIGN.
REINFORCED CONCRETE DESIGN.
HEATING AND VENTILATION.
MOTOR CAR ENGINEERING AND DESIGN.
ENGINEERS' QUANTITIES AND ESTIMATING.
PRACTICAL MATHEMATICS.
ENROLMENT:
17th, 19th and 21st SEPTEMBER, 7 to 9 p.m.
Prospectus will be forwarded on application.
J. W. BISPHAM, Principal.
9384

PUBLIC NOTICES (continued) Page 2.
SITUATIONS OPEN, Page 2.
SITUATIONS WANTED, Page 2.
AUCTIONS, Page 72.
BUSINESSES and PREMISES (For Sale, etc.). Page 72.
MACHINERY, &c., WANTED, Page 4.
EDUCATIONAL, Page 2.
PATENTS, Page 4.
PARTNERSHIPS, Page 2.
AGENCIES, Page 2.
FOR SALE, Page 4.
WORK WANTED, Page 4.
FOR HIRE, Page 72.

For Advertisement Rates see Leader Page.

PUBLIC NOTICES

University of London.
University College.

RAMSAY LABORATORY OF CHEMICAL ENGINEERING.

RAMSAY PROFESSOR ... W. E. GIBBS, D.Sc.
LECTURER ..... J. P. MULLEN, M.Sc., Eng.

The Ramsay Laboratory of Chemical Engineering, instituted in 1923 as part of the memorial to the late Sir William Ramsay, K.C.B., F.R.S., provides a Course of Training in Chemical Engineering.

The Course includes Lectures on the Principles of Chemical Engineering, Drawing-office Work, the Design of Plant to perform specific duties, and the Economic Operation of Large-scale Plant. Valuable data required to put plant design on a scientific basis have been accumulated in the laboratory, and students are made familiar with their use.

In addition to laboratory investigations, students have, by the courtesy of the Directors of certain companies, been able to investigate and report upon the operation and efficiencies of actual factory plants.

This close contact of the Department with industry is of the greatest value to the students and is fostered in every possible way.

The Course is designed to meet the demand of the manufacturing industries for men trained in the application of scientific methods to the design and operation of industrial chemical processes and plant. At the present moment there are more vacant appointments to be filled than there are candidates to fill them.

Students who have obtained a Bachelor's Degree in Chemistry and are desirous of entering industry can, simultaneously with the Course of Training in Chemical Engineering, take the degrees of M.Sc. or Ph.D. in that subject.

Special facilities are provided for research.

The NEXT SESSION will COMMENCE on MONDAY, OCTOBER 1st.

Composition fee for the full session, 30 guineas; for the term, 11 guineas.

A detailed prospectus can be obtained on application to—

C. O. G. DOUIE,
Secretary.

University College, London,
(Gower-street, W.C. 1.) 9371

University of Bristol.

FACULTY OF ENGINEERING.

APPLICATIONS are INVITED for the APPOINTMENT of ASSISTANT LECTURER and DEMONSTRATOR in MECHANICAL ENGINEERING. Salary, £300 per annum.—Forms of application and full particulars may be obtained from the REGISTRAR, Merchant Venturers' Technical College, Unity-street, Bristol, to whom applications should be forwarded on or before September 5th. 9312

TO DREDGING CONTRACTORS.

Harbour of Waterford.

WATERFORD HARBOUR COMMISSIONERS.

The Waterford Harbour Commissioners are prepared to receive TENDERS for DEEPENING the BERTH known as the "Grain Berth" and situate on the north side of the river Suir at Waterford.

The area to be deepened is approximately 450ft. long by 75ft. wide, having a surface level of about 22ft. below low water ordinary spring tides, and is to be deepened to 25ft. below L.W.O.S.T.

The material to be removed is rock.

Copies of the plan, specification and conditions can be obtained on application to the Harbour Engineer, Harbour Office, Waterford, on payment of Five Guineas, which will be returned in case a bona fide Tender is duly made.

Tenders must be addressed to "The Chairman," Waterford Harbour Commissioners, Harbour Office, Waterford, in a sealed cover, endorsed "Grain Berth Tender," and must be delivered not later than One o'clock p.m. on Saturday, the 15th day of September, 1928. Contractor to commence work during the first week in May, 1929.

The lowest or any Tender will not necessarily be accepted.

Dated the 28th day of August, 1928.

AUSTIN A. FARRELL,
Secretary and General Manager to the Waterford Harbour Commissioners.
Harbour Office, Waterford. 9402

South Indian Railway Company,
LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1.—PLATFORM ROOFING.
2.—STEEL RAILS and FISH-PLATES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Platform Roofing," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, 21st September, 1928, in respect of Specification No. 1, and not later than Twelve Noon on Friday, the 14th September, in respect of Specification No. 2.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of Specifications Nos. 1 and 2.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1,
29th August, 1928. 9415

The Bengal and North-Western
RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of—

SIX LOCOMOTIVE ENGINES and TENDERS,

as per specification to be seen at the Company's Offices.

Tenders, addressed to the undersigned, and marked "Tender for Locomotives," with name of firm tendering, to be lodged not later than Noon on Tuesday, the 25th day of September, 1928.

For each specification a fee of £1 will be charged, which cannot, under any circumstances, be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
W. R. IZAT,
Managing Director.

237, Gresham House, Old Broad-street,
London, E.C. 2, 28th August, 1928. 9374

The Madras and Southern
MAHRATTA RAILWAY COMPANY, Limited,

invite TENDERS for :—

(1) 95 TONS STRUCTURAL STEEL WORK for ENGINE PAINT and VALVE SHOP (together with ASBESTOS SHEETING, PATENT GLAZING, C.I. PIPING, &c. &c.).
(2) 599 STEEL TYRES for ENGINES and TENDERS.
(3) 85,300 FISH BOLTS with SPECIAL NUTS for use with B.S. 90/R, B.S. 60 lb. and B.S. 60-R F.F. RAILS (Approximate total weight equals 74 Tons).

Tenders for (1) are due in by 10.30 a.m. on Monday, 17th September, 1928.

Tenders for (2) and (3) are due in by 2 p.m. on Tuesday, 18th September, 1928.

Tender forms obtainable at address below; fee for Nos. (1) and (2) One Guinea each, and for No. (3) Half a Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices :
25, Buckingham Palace-road,
Westminster, S.W. 1. 9388

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, MAN, Preferably with Railway Experience, knowledge of Spanish essential, for important position, commercial undertaking, South America.—Write fully, experience, qualifications, salary expected, to Box S.A., c.o. Advertisement Dept., 5, New Bridge-street, E.C. 4. 9382 A

SITUATIONS OPEN (continued)

WANTED for India, ONE or TWO INDIAN GENTLEMEN who have graduated in Civil Engineering at an English University, to undergo Course of Training in Reinforced Concrete Pipe Construction and subsequently fill appointments in India.—Write full particulars, age and qualifications to Z.L. 395, c/o Deacon's, Fenchurch-avenue, London. 9297 A

WANTED for the East, ENGINEER, with Thorough experience of all branches of Perro-concrete Engineering, also some commercial knowledge would be required to obtain orders for new construction; age about 30.—Write, with full particulars, to Z.M. 396, c/o Deacon's, Fenchurch-avenue, London. 9296 A

WANTED IMMEDIATELY, YOUNG ENGINEER, who can prove ability and willingness to take extreme care with every detail of his work. Thorough training in workshops, drawing-office and toolroom essential. Ability to make new designs, erect small plant and organise production on time-saving basis also necessary. Good remuneration and encouragement to young man with initiative and the capacity for taking great pains with everything he does.—Address fully, stating salary required, 9375, The Engineer Office. 9375 A

ASSISTANT EDITOR WANTED for London Mechanical Engineering Journal. State terms, age, salary, &c.—Address, P4897, The Engineer Office. P4897 A

C.A. WANTED for Large Shipbuilding and Engineering Company in the Far East. Age 28-30. Must have good knowledge of Engineering matters. Good salary and prospects to suitable man.—Apply by letter to "C.A.," c/o Abbotts, Ltd., 32, Eastcheap, London, E.C. 3. P4889 A

ELECTRIC ARC WELDING.—Well-known Firm of Welding Wire Makers REQUIRE experienced SALESMAN for London and Birmingham area. Applicants should send fullest particulars of their qualifications.—Write, "C.Y.," c/o J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 9390 A

ENGINEER, Good Social Standing and Sound Mechanical training through workshop, and experience Oil Engines, Light Structural Work, &c., for CEYLON. Age 26-30. Salary up to £600 p.a. Also JUNIOR ENGINEER, age about 23. Salary £300-£360. Free quarters provided.—CALL C. W. PETTY AND COMPANY (APPOINTMENT SPECIALISTS), 58, HAYMARKET, S.W. 1. 'PHONE, GERRARD 3412-3. P4890 A

FIRST-CLASS MACHINE TOOL SALESMAN REQUIRED for London and South of England; must have established connections amongst engineering firms and railways, and be thoroughly acquainted with modern production methods. Only those applicants possessing first-class testimonials will be considered.—Address, P4888, The Engineer Office. P4888 A

LARGE MANUFACTURERS of High-grade Steel REQUIRE competent MAN to act for them in London and district. Must be fully competent to deal with technical points and have recent selling experience in High-grade Steels. Only applicants who have had actual experience in negotiating large business can be considered. Give full details of experience, terms, &c.—Address, 9408, The Engineer Office. 9408 A

REQUIRED in a Large Motor Car Works, a First-class CHIEF JIG and TOOL DESIGNER. Applicants must be accustomed to production of high-class work at low cost and to be able to settle methods of operation, fix production times and to superintend design of tools. Only really first-class men need apply. Others will be wasting their time. Give particulars of experience, age, &c., and salary required.—Address, 9407, The Engineer Office. 9407 A

SALESMAN WANTED by Gas Undertaking; Experience in Engineering and Shipbuilding more desirable than experience in gas; good address necessary, and University Degree desirable.—Address, 9266, The Engineer Office. 9266 A

STORES SUPERINTENDENT, Accustomed to dealing with large quantities of Small Metal Parts from Strip and other Metals and able to control work in progress, finished articles, and packed stocks. Only first-class man need apply. State fully experience, age and salary required.—Address, 9377, The Engineer Office. 9377 A

SYNTHETIC AMMONIA and NITRATES, Ltd. (associated with Imperial Chemical Industries, Ltd.) REQUIRE the SERVICES of MECHANICAL ENGINEERS, age 25-32. Applicants must possess first-class practical experience and must have had university or similar technical training. Previous experience on Design and Lay-out Work essential.

The work to be undertaken is the Design of Works Plant.

Duties will commence in the drawing-office, but promotion and salary will be entirely dependent upon ability and personality.

Replies to be addressed to the CHIEF ENGINEER, Synthetic Ammonia and Nitrates, Ltd., Billingham, Stockton-on-Tees. 9317 A

TOOL STEELS.—Efficient SALESMAN for London and Midlands WANTED by well-known Firm of Tool Steel Makers. Applicants with knowledge of Metallurgy and Modern Heat Treatment are invited to send full particulars of their qualifications.—Write, "O.M." c/o J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 9389 A

WORKS MANAGER WANTED for Firm of Aero-engine Manufacturers. Applicants should have held equivalent position previously; have had considerable experience of engineering work of highest accuracy and finish, and have an all-round practical knowledge of best shop methods and systems. Ability to handle labour problems satisfactorily is essential.—Address, giving full particulars of qualifications and remuneration required, 9360, The Engineer Office. 9360 A

WANTED, Experienced RAILWAY CARRIAGE and WAGON DRAUGHTSMEN.—Apply by letter, giving particulars of experience and salary required, the BIRMINGHAM RAILWAY CARRIAGE and WAGON CO., Ltd., Smethwick. 9401 A

WANTED, First-class DRAUGHTSMAN for Constructional Steel Work.
Apply, with references, &c., to R. WHITE and SONS, Engineers, Widnes. 9318 A

SITUATIONS OPEN (continued)

WANTED, STRUCTURAL STEEL DRAUGHTSMEN. Permanency for suitable men. State experience and salary required.—Apply, SANDS, Colwick, Nottingham. P4898 A

A CONSTRUCTIONAL ENGINEERING WORKS in London REQUIRE the SERVICES of a DRAUGHTSMAN; only those having a good experience in Structural Steelwork need apply. State age, experience and salary required.—Address, 9370, The Engineer Office. 9370 A

DRAUGHTSMEN.—HEAD DRAUGHTSMAN and ASSISTANT REQUIRED in drawing-office engaged in producing Bottle-making Machinery. Previous experience in bottle making not essential. Salaries £1000 and £350 respectively.—Address, giving age, qualifications, experience, &c., 9367, The Engineer Office. 9367 A

DRAUGHTSMAN REQUIRED IMMEDIATELY, with first-class experience in the design of Industrial Furnaces.—Reply fully to STEIN and ATKINSON, Ltd., 47, Victoria-street, London, S.W. 1. 9400 A

DRAUGHTSMAN REQUIRED, London, Experienced in Gas Producers and Furnace Work. Age, refs., salary. Also good JUNIOR.—Address, 9411, The Engineer Office. 9411 A

DRAUGHTSMAN WANTED for Confectionery Works in the North of England, qualified in Machinery Design and Lay-out Work. Age about 30.—Address, giving experience, salary required, and references, 9412, The Engineer Office. 9412 A

DESIGNER WANTED; Must Have Had First-class experience of Bottling and Aerated Water Machinery. State age, experience, and salary required.—Address, 9396, The Engineer Office. 9396 A

DORMAN, LONG and CO., Ltd., Middlesbrough REQUIRE the SERVICES of SEVERAL DRAUGHTSMEN, about 24 years of age, experienced in detailing Constructional Work for all kinds of Steel-framed Buildings.—Apply by letter, stating age, training, experience, and salary required, to the MANAGER, Messrs. Dorman, Long and Co., Ltd., Bridge and Constructional Works, Middlesbrough. 9397 A

DRAUGHTSMAN, with Pumping Machinery Experience, REQUIRED for East Midlands. State experience, previous employers, age, salary required.—Address, 9311, The Engineer Office. 9311 A

FOUR Experienced DRAUGHTSMEN REQUIRED by a large Steel and Engineering Works in Sheffield, one with experience in Machine Tools, one with experience in Furnaces and Steelworks Plant, one for heavy Hydraulic Plant, and one for work on Steel Structures and Buildings.

State full particulars of training and past experience, age, salary required, and how soon at liberty.

Applicants under 26 years of age will not be considered.—Replies should be addressed, "ENGINEERS' DEPT.," P.O. Box No. 57, Sheffield 9381 A

JUNIOR DRAUGHTSMAN REQUIRED by Firm manufacturing Automobile Brakes in London.—Apply, stating age, experience, and salary required, to Box 68, c.o. Dixons, 195, Oxford-street, W. 1. P4886 A

JUNIOR DRAUGHTSMAN, with Experience in Machine Detail Work, Plant Lay-out.—Address, stating age, salary required, and full particulars, 9413, The Engineer Office. 9413 A

SENIOR DRAUGHTSMAN or DESIGNER WANTED in a Large Heavy Motor Vehicle Works in the South of England. Application should be made by letter, giving full particulars of experience, age, and salary required.—Address, 9324, The Engineer Office. 9324 A

STRUCTURAL DRAUGHTSMEN.—TWO SENIORS REQUIRED for London. State age, experience, salary required. Men with knowledge of Power Station Building Practice preferred, but not essential.—Address, P4891, The Engineer Office. P4891 A

REQUIRED by a European Firm of Structural and General Engineers in India, an ASSISTANT FOREMAN in their Structural Department. Applicants must have experience in Template Making and be accustomed to Bridge, Roof and General Structural Work. Must be a bachelor and not more than 25 years of age.—Apply, stating age and full particulars of experience, to Z. R. 463, care Deacon's Advertising Offices, Fenchurch-avenue, London. 9392 A

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Sir John Pringle's Report.

THE annual report of Colonel Sir John Pringle on the railway accidents of 1927 was issued on Saturday, August 25th. The fourteen collisions and three derailments inquired into during the year are commented upon. Of the 310 passengers injured in those accidents only 79 required detention or treatment in hospital. Recommendations were made in thirteen cases; in ten they were wholly or partially adopted, and in one case the matter was still under consideration by the railway company. The number of collisions that could possibly have been avoided by automatic train control was greater than in 1926, but not to such an extent as would justify immediate action in the direction of the adoption of automatic train control, which subject is shortly to be reconsidered by a Committee which has been appointed by the Minister of Transport. The figures as to accidents and casualties at railway level crossings during 1927, notwithstanding the continued growth and altered character of road traffic, justify broadly the conclusion that the danger to the public using such crossings has not increased. Constant action, it is added, is being taken to improve the protective arrangements where required. Of the 200 fatal accidents to railway servants 62·0 per cent. were due to want of care, and 26·5 per cent. were due to misadventure. There were only four men killed in coupling accidents.

Speed of Heavy Motor Vehicles.

A NEW Order has been issued by the Minister of Transport revising the speed limits at which heavy motor vehicles—that is motor vehicles exceeding 2 tons in weight unladen—may be driven on public roads. The Order is to come into force on October 1st, and, in general, will raise the limits for vehicles fitted with pneumatic tires or with tires which, though not pneumatic, are of soft or resilient material. Heavy motor vehicles without trailers will, if they are fitted with pneumatic tires, be permitted to travel at 20 m.p.h. instead of at the present maximum of 12 m.p.h., and those fitted with solid rubber tires or with partly solid and partly pneumatic tires at 12 m.p.h. In the case of heavy motor vehicles with trailers attached, both the vehicle and the trailer being fitted with pneumatic tires, the speed limit will be 12 m.p.h. in place of the present 5 m.p.h. If the vehicle and its trailer are fitted with solid rubber tires or partly with solid and partly with pneumatic tires, the new speed limit will be 8 m.p.h. The Order also provides for the compulsory fitting of reflecting driving mirrors to all heavy motor vehicles except those carrying a conductor or other person at the rear who can communicate the effect of signals received from other vehicles behind his own to his driver.

A Catapult Air Mail.

AN interesting announcement was made by the Postmaster-General this week regarding the s.s. "Ile de France" and the use of her aeroplane launching catapult as a means of expediting the landing of mails for the United States. For each outward voyage of that ship letters will be accepted in London up to noon on the day of dispatch for inclusion in a mail which will be conveyed from the vessel by aeroplane to New York, the aeroplane leaving the ship before her arrival in port. It is anticipated that the arrangement will enable the correspondence to reach New York about a day in advance of the vessel's arrival. A special air fee of 2s. 6d. per ½ oz. will be charged in addition to the ordinary postage. If desired the correspondence may be transmitted to its destination in the United States by air mail after it has been landed by the ship's aeroplane. For this additional service the fee will be 9d. per ounce. The launching of aeroplanes from ships by means of catapults is by no means a novelty. It was tried in the United States before the war, and has since been brought to a considerable degree of perfection. In this country it has not been extensively employed, although it is understood that several of our submarines now carry catapult equipment, by means of which small folding aeroplanes carried on board can be launched from them.

Wireless Patents.

ON Friday, August 24th, the Comptroller-General of the Patent Office announced that he had decided to grant an application made by the Loewe Radio Company for a licence to manufacture a wireless set which is said to be equivalent to a three-valve set, and which is being sold abroad for less than £2. The applicants sought to secure a modification of the Marconi Company's 12s. 6d. royalty per valve holder and of other conditions involved in the use of Marconi patents in the manufacture of wireless sets. The royalty has hitherto been paid on the number of valve holders, and the suggestion was made by the respondents that three valves in one holder should be paid for at the same rate as three separate valve holders. The Tribunal held, however, that a case of abuse of monopoly rights had been established, and ruled that three valves in one container should be treated as one triple valve, and that the royalty to be paid on it should be 10s. The Marconi Company's standard licence includes restrictions as to imports and exports, and requires royalty payment in respect of other apparatus made by the licensee in which Marconi patents are not involved. Under the new arrangement, however, the Loewe Company will not pay royalties on apparatus which does not include the patents. On Monday of this week a special Tribunal of the Patent Office also approved an application by the Brownie Wireless Company for compulsory licences under Marconi patents. Hitherto the Brownie Company has sold a two-valve amplifier for £2 2s., but it was anxious to bring out a new set involving the adoption of Marconi patents. On approaching the Marconi Company these manufacturers were informed that the royalties would be 12s. 6d. per valve holder, not only on the new sets but on other manufactures of the concern. This meant that 25s. would have to be added to the cost of the existing £2 2s. set, despite the fact that it involved no Marconi patents. The Brownie Company therefore appealed to the Comptroller under Sec. 27 of the Patents and Designs Act, alleging abuse of monopoly rights, which prevented it expanding a legitimate British industry for the benefit of the general public. In his decision the Comptroller remarked that the Marconi Company held a kind of super-monopoly, and the terms offered to the applicants were unreasonable. He therefore granted a compulsory licence to the firm and reduced the royalties from 12s. 6d. for each valve holder to 10 per cent. on the wholesale selling price, with a minimum charge of 5s. on the first valve holder and 2s. 6d. for each additional one.

A Large Shipbuilding Order.

THE announcement is made that Swan, Hunter and Wigham Richardson, Ltd., have received an order from Paterson Steamships, Ltd., of Canada, and other Canadian shipping companies for ten steamers for the Canadian lake service. It is understood that the new ships will be generally similar in type to the ss. "Torondoc" and her four sister ships, which were built for the same owners last year. They have a length of about 253ft. and a raised quarterdeck 100ft. long, with a sunk forecastle 35ft. in length. There are seven cargo hatches. The ships are propelled by single-screw three-crank engines, steam being supplied from two single-ended boilers. This new order comes at a time when the Neptune yard of the firm is well employed, and it is generally understood that some of the new ships will be constructed at Swan, Hunter's other Tyneside yards and also at the yards of the allied firm of Barclay, Curle and Co., Ltd., on the Clyde. It is stated that the new order is the biggest in point of view of the number of ships ordered which has ever been placed on the Tyne.

A Contract for Bronze Wire.

AT a time when Mr. Baldwin is appealing to the employers of Great Britain to take on unemployed workers, the Post Office has placed an order for bronze wire with a firm in France. The prices quoted by British firms were somewhat in excess of that quoted by the French manufacturer, and it was apparently thought that the "ring" in this country was responsible for the difference. It is stated that the Post Office did not place the order abroad until it had made every effort to induce the British firms to quote a reasonable price, and it even suggested a figure which would be acceptable. The firms forming the alleged "ring," however, apparently consider that if they had accepted the contract at the Government's price they would have lost money. They contend that the Post Office is endeavouring to dictate terms, irrespective of economic and export conditions. Labour costs in England, they point out, are higher than they are abroad. The hours are shorter and the quality of British goods is superior. The British firms also maintain that the French, with no unemployment and the advantage of the exchange, could undersell them even if they reduced the price below that suggested by the Post Office. The official explanation for the high prices quoted by British firms is, however, that, with two exceptions, the manufacture of cables is in the hands of a ring known as the Telephone Cable Manufacturers' Association, which is said to quote higher prices to the Post Office than to the Dominions and the Irish Free State and refuses the department permission to examine costs for comparative purposes. It is therefore considered that the Post Office should have a free hand to accept foreign tenders if the British prices are held to be excessive.

The Largest Diesel-Electric Propelled Tanker.

AN event of more than usual interest took place on the Clyde on Wednesday last, August 29th, when successful trials were carried out of the Diesel-electric propelled oil tanker "Brunswick," which has been built by Scott's Shipbuilding and Engineering Company, Ltd., of Greenock, to the order of the Atlantic Refinery Company, of Philadelphia. The new tanker, which is the largest vessel of its type afloat, has a length between perpendiculars of 469ft., with a beam of 63ft. and a moulded depth of 36ft. 9in. She has a deadweight carrying capacity of about 13,000 tons, and is designed for speed of 11 knots. Her propelling machinery comprises four sets of six-cylinder four-stroke oil engines of the Ingersoll-Rand type, which were constructed by Carels Frères, of Ghent. They are each designed to give an output of 750 B.H.P. at 225 r.p.m., and are coupled to 600-kW, 250-volt, direct-current generators, built by the British Thomson-Houston Company, Ltd., of Rugby. These sets provide current for the 2800 S.H.P. propelling motor, which runs at a speed of 95 r.p.m. The machinery is controlled from the bridge by an attachment to the Sperry automatic helmsman, and course recorder. Both the bridge and machinery spaces are arranged aft. The trials showed that with a total displacement of 17,250 tons, a speed of 11·48 knots was attained on the measured mile at Skelmorlie. Speaking at the luncheon on board, Mr. James Brown, of Scott's Shipbuilding and Engineering Company, Ltd., proposed "The Success of the 'Brunswick,'" and congratulated Mr. Lester M. Goldsmith, the owners' consulting marine engineer, who is responsible for the designs of the machinery lay-out, on the successful performance of the vessel. Mr. Brown further referred to the presence on board, among many engineers, shipbuilders, and shipowners, of Mr. Sam Mavor, the brother of the late Mr. Henry Mavor, of Mavor and Coulson, Ltd., and also Mr. Charles Day, of Mirrlees, Bickerton and Day, Ltd., who were responsible for the pioneer machinery of the electrically driven ship "Tynemount," which was built by Swan, Hunter and Wigham Richardson, Ltd., before the war.

The Government Airship R 101.

IN company with others, we had an opportunity of making a close inspection on Thursday of last week of the Government airship "R 101," now in course of construction at the Royal Airship Works, Cardington, near Bedford. Elsewhere in this issue we detail the results of our inspection. In many of her features this vast ship is entirely different from any previously constructed. She represents a definite break with the Zeppelin tradition hitherto more or less faithfully followed in this country's airships. When she will be ready for her trial flights no one seems to know, but the progress being made is now very rapid, and we would not be surprised to see her in the air early next year. As for her cost, it is impossible apparently to arrive at any precise or even approximate figure. We have heard it guessed at a good half million and are disposed to accept that figure as fairly accurate. It should be remembered, however, that a considerable part of the cost represents experimental expenditure which would not have to be incurred again if a second ship were to be built, even although the design were considerably altered. In all probability a second vessel of the same size could be constructed for between two and three hundred thousand pounds. For the benefit of those who desire to investigate the commercial possibilities of airship operation, we may add that the airship, carrying a hundred passengers, is expected to make the voyage to India in four or five days, and to fly from New York to Cardington in about 60 hours. The time occupied on the flight from India to this country should be little different from that spent on the out ward voyage, but we can find no one willing to put any estimate on the outward voyage from this country to America. In addition to the prime cost of the airship and the running expenses a considerable sum is involved in the provision of what is known as the ground organisation. That organisation includes the establishment and maintenance of an elaborate meteorological service over the route served and the erection of terminal and intermediate sheds, mooring towers, hydrogen plants, fuel tanks, and other equipment.

Pulverised Coal on a Cargo Liner.

IN a Journal note in our issue of July 20th we referred to the experimental installation of "Woodeson" pulverised fuel-burning equipment on one of the single-ended boilers on the Blue Star liner "Stuartstar," which sailed from the Tyne for Buenos Aires about the middle of July. Yesterday—Thursday, August 30th—the "Stuartstar" was scheduled to return to London after a most successful voyage. The results, we learn, have been so encouraging that it is proposed by the owners to fit one of the double-ended boilers of the ship with similar equipment. When the steamer next leaves London she will have twelve of her twenty-four furnaces equipped for pulverised fuel burning. The coal which was used on the recent voyage, we are informed, was ordinary Northumberland slack containing from 13 to 14 per cent. of ash, which slags freely. This quality of fuel was specially chosen in order to show that special coal need not be employed. We have already referred to the motor-driven pulveriser and blower with the feeding hopper and bin, which form the single unit of the pulverised fuel equipment. This plant is accommodated in a small space arranged in the cross bunkers forward of the stokehold, and provision has already been made for increasing the number of burners. Clarke, Chapman and Co., Ltd., of Gateshead, are to be congratulated on the success of the installation, and the owners of the ship on their decision to extend the scope of the experimental installation.

The Flexibility of Plain Pipes.

By J. R. FINNIECOME, M. Eng. (Zurich), M. Soc. Ing. C. (France).

No. III.*

(IV.) Analysis of Tests on Pipe Bends on the Basis of the Karman Theory.

In the preceding article the theoretical deflection of a pipe bend was compared with the test deflection. It was found for various types and sizes of bends that the test deflection was about one to five times the theoretical deflection.

When examining the test carried out by Bantlin, the author pointed out that the large difference in the test and theoretical deflections was due to a number of factors which the ordinary bending theory did not take into account.

After the publication of Bantlin's theory and test results on pipe bends Dr. Th. v. Karman†, in a quest to find the true relationship between the theoretical and test deflections, investigated the matter and found that the discrepancy existing between the theory and experiments was largely due to the usual assumption of the bending theory; that, as the cross section of a bar remains unaltered, so must also the cross section of a thin pipe when under bending conditions. Karman considered the deformation of the circular thin pipe to be such that the cross section became oval. This flattening effect of the circular cross section has to be carefully studied, as it explains to a large extent the reason for the discrepancy.

As pointed out previously, the theoretical and test deflections of the bar type and cast iron bends agree closely, and only the mild steel pipes show any large discrepancies. When a curved bar is being bent each fibre of the material will elongate in accordance with the change in curvature only if it is not forced towards the neutral axis. With a thin circular cross section the increase in curvature, due to the tensile stress on the outside radius, and to the compressive stress on the inside radius, forces the wall on both sides towards the neutral axis, so that the circular cross section becomes oval. The flattening effect on the original circular cross section has been considered both by Dr. Th. v. Karman (1911) and Prof. H. Lorenz (1912).‡

Dr. Karman gave a mathematical expression for correcting not only the theoretical deflection, but also the theoretical stress. A year later Prof. H. Lorenz published a similar mathematical expression which corrects the theoretical deflection. Karman based his investigation on the principle of the smallest deformation, while Lorenz based his on the equilibrium of the forces on a wall element. The mathematical expressions arrived at make it possible to correct the theoretical deflection and so to obtain the actual deflection, which should correspond to the test deflection. Any other slight difference between the corrected theoretical deflection and the test deflection may be due to (*a*) variable thickness of the pipe, (*b*) thinning of the material caused by tension on the outside radius during the bending operation, (*c*) thickening of the material caused by compression on the inside radius during the bending operation, and (*d*) creases or waves formed on the inside curvature (compressive side of the bend).

In this article we shall consider (A) the deflection-thrust correction factor, (B) the deflection-stress correction factor.

(A) The Deflection-thrust Correction Factor.

(1) *Karman Deflection-thrust Correction Factor.*—This factor is expressed by the following formula:

$$K_H = \frac{10 + 12\,\varphi^2}{1 + 12\,\varphi^2} \quad . \quad . \quad . \quad (19)$$

where

K_H = Karman deflection-thrust correction factor (Table IX. and Fig. 18).

$\varphi = \frac{\delta\,R}{r^2}$ = pipe factor which characterises the pipe bend. This factor contains the three essential dimensions which will determine any bend.

δ = thickness.

R = mean radius of bend.

r = mean radius of cross section of the pipe.

The above expression (19) is used for a pipe factor equal to or greater than 0·3. If the value of the pipe factor is 0·2 to 0·3, then the following expression should be used:

$$K_H = \frac{105 + 4136\,\varphi^2 + 4800\,\varphi^4}{3 + 536\,\varphi^2 + 4800\,\varphi^4} \quad . \quad . \quad (20)$$

Usually the pipe factor is equal to 0·3 or larger than 0·3, so that the expression (19) can be used for most bends.

(2) *Lorenz Deflection-thrust Correction Factor.*—The Lorenz factor is expressed as follows:—

$$L_H = 1 + \frac{3}{4\,\varphi^2} \quad . \quad . \quad . \quad (21)$$

The author has calculated the Karman and Lorenz factors for $\varphi = 0{\cdot}3$ to 2. The values are tabulated in Table IX. and plotted in Fig. 18, for various pipe factors. The Lorenz factor is found to be slightly larger than the Karman factor. In comparing the corrected deflection with the test deflection we shall here use the Karman factor. By multiplying the theoretical deflection by the deflection-thrust correction factor we obtain the corrected theoretical deflection. On the basis of the Karman theory the ordinary theoretical formula (3) becomes

Table IX.—*Karman and Lorenz Deflection-Thrust Correction Factors for various Pipe Factors.*

Pipe factor. $\varphi = \frac{\delta\,R}{r^2}$	Karman factor. K_H	Lorenz factor. L_H
0·30	5·325	9·333
0·40	4·082	5·688
0·50	3·250	4·000
0·60	2·691	3·083
0·70	2·308	2·530
0·80	2·037	2·172
0·90	1·839	1·926
1·00	1·692	1·750
1·10	1·579	1·620
1·20	1·491	1·521
1·30	1·423	1·444
1·40	1·367	1·383
1·50	1·321	1·333
1·60	1·283	1·293
1·70	1·252	1·259
1·80	1·219	1·231
1·90	1·203	1·208
2·00	1·183	1·187

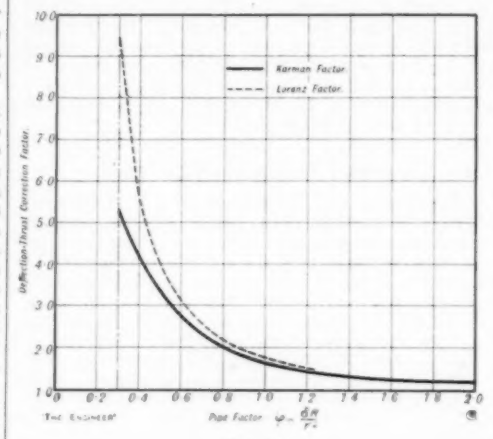


FIG. 18

$$\Delta_{KH} = \frac{H}{E\,.\,I}\int K_H\,y^2\,ds \quad . \quad . \quad . \quad (22)$$

where Δ_{KH} is the Karman deflection, and the formula (12) for the lyre-shaped bend becomes—

$$\int_A^E K_H\,y^2\,ds = 2\,R_1^3\left\{K_{H_2}\,k_1^3\left[\tfrac{3}{2}\gamma - 2\sin\gamma + \tfrac{1}{4}\sin 2\gamma\right] + K_{H_1}\left[[k_1 + (1 + k_1)\cos\beta]^2\,\gamma + 2\,[k_1 + (1 + k_1)\cos\beta]\sin\gamma + \tfrac{1}{4}\sin 2\gamma + \tfrac{1}{2}\gamma\right]\right\} \quad . \quad . \quad (23)$$

where—

$$K_{H_2} = \frac{\delta\,R_2}{r^2} \quad ; \quad K_{H_1} = \frac{\delta\,R_1}{r^2}$$

$$\Delta_{KH} = \frac{H}{E\,I}\int_A^E K_H\,y^2\,ds \quad . \quad . \quad . \quad (24)$$

Professor Hovgaard has also given a deflection-thrust correction factor as follows:—

$$\frac{48\,h^2R^2 + 10\,r^4}{48\,h^2R^2 + r^4} \quad . \quad . \quad . \quad . \quad (25)$$

where $2\,h$ = wall thickness;

R = mean radius of bend;

r = mean radius of cross section of pipe.

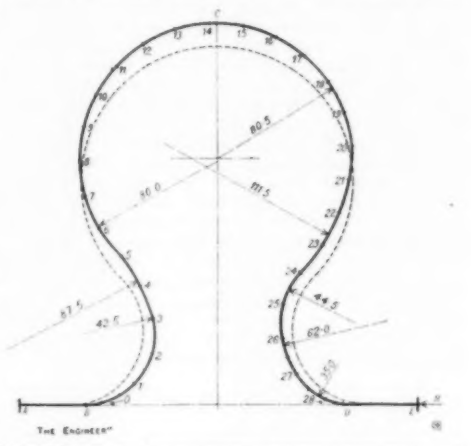
By inserting the same symbols as used in the Karman factor, *i.e.*, $2\,h = \delta$, we find that the Hovgaard factor is exactly the same as the Karman factor.

(3) Graphical Method of Determining the Corrected Deflection, using the Karman Factor.

For calculating the corrected theoretical deflection, formula (22) has been used, and by determining the Karman factor for each pipe element ds with varying mean radius of bend, we are able to obtain the sum of $K_H\,y^2\,ds$. This method has been used for the actual shape of the 200 mm. Bantlin lyre-shaped bend. As the radius varied to some extent, Bantlin had to introduce only two radii, so as to simplify his mathematical expression for determining the deflection with his exact bending formula. The writer noticed that y_{max} did not correspond with the actual dimensions of the pipe for the 200 mm. and 125 mm. bend, and for this reason he analysed these two bends by the graphical method. He was thus able to determine a number of interesting ratios which will be given later.

(*a*) *200 mm. Bantlin Lyre Bend.*—The actual mean curvature of this pipe bend, which has a varying radius, was drawn to a scale equal to one-tenth of the actual dimensions measured by Bantlin—Fig. 19, full line. The shape of the bend used for the mathematical calculation by Bantlin is shown by a dotted line. It will be seen that the distance y_{max} of the actual shape of the bend is larger than the assumed mathematical shape. This difference naturally affects the theoretical deflection and also the corrected theoretical deflection.

The mean curvature of the actual bend A C E, full line, was divided into equal arc elements ds = 20 cm., commencing at point B and finishing at point D, where the curvature of the bend is tangential to the direction of thrust A E. The mid points of each arc element were determined and were numbered from 0 to 28, and finally the pipe factor for each element was found. These particulars are given in the table accompanying Fig. 19 with the Karman



1	2	3	4	5	6	7	8
	$d\,s$ cm.	y cm.	y^2 cm^2.	R cm.	φ.	K_H.	$K_H y^2$
0	20	2·0	4	42·5	·4293	3·80	15
1	,,	12·5	156	,,	,,	,,	593
2	,,	30·5	930	,,	,,	,,	3534
3	,,	51·5	2600	,,	,,	,,	9880
4	,,	70·5	4970	87·5	0·984	1·891	8400
5	,,	88·0	7744	,,	,,	,,	14650
6	,,	104·0	10820	80·0	0·808	2·022	21900
7	,,	123·5	15130	,,	,,	,,	30500
8	,,	144·0	20740	,,	,,	,,	41800
9	,,	164·0	26900	80·5	0·813	2·011	54080
10	,,	183·0	33490	,,	,,	,,	67350
11	,,	200·0	40000	,,	,,	,,	40440
12	,,	213·0	45370	,,	,,	,,	91240
13	,,	221·5	48900	,,	,,	,,	98330
14	,,	225·0	50630	,,	,,	,,	101820
15	,,	223·5	49950	,,	,,	,,	100450
16	,,	217·5	47300	,,	,,	,,	95120
17	,,	206·0	42440	,,	,,	,,	85340
18	,,	191·0	36480	,,	,,	,,	73360
19	,,	172·5	29750	,,	,,	,,	59830
20	,,	152·0	23100	,,	,,	,,	46450
21	,,	131·5	17290	,,	,,	,,	34760
22	,,	112·5	12650	111·5	1·126	1·586	19680
23	,,	94·0	8840	,,	,,	,,	13760
24	,,	77·5	6000	44·5	·449	3·672	22030
25	,,	59·5	3540	,,	,,	,,	13000
26	,,	39·0	1520	62·0	0·626	2·591	3940
27	,,	19·5	380	,,	,,	,,	984
28	,,	4·5	20	35·0	0·354	4·56	91
			587644				1153327
			$d\,s\int y^2 = 20 \times 587644 = \int y^2\,d\,s = 11{\cdot}75288 \times 10^6$				$d\,s\int K_H\,y^2 = 20 \times 1153327 = \int K_H\,y^2\,d\,s = 23{\cdot}06654 \times 10^6$

FIG. 19

factor in Col. 7 and $K_H y^2$ in Col. 8. A summary of the particulars obtained by the graphical method for this pipe bend is given in Table X., where Δ (graph)

Table X.—*200 mm. Lyre Bend (Bantlin). Particulars Obtained by Graphical Method of Determining the Deflection for the Actual Shape of the Bend and Using the Karman Deflection-Thrust Correction Factor.*

d_1	21·52 cm.
d	20·19 cm.
r	10·42 cm.
δ	0·665 cm.
H	900 kilos.
E	$2{\cdot}103 \times 10^6$ kilos./cm.^{2}
I	2371·1 cm^4.
$\int y^2\,ds$	$13{\cdot}515 \times 10^6$ cm.^{3}
$\int K_H y^2\,ds$	$44{\cdot}556 \times 10^6$ cm.^{3}

$$\Delta\ (\text{graph}) = \frac{H}{E\,I}\int y^2\,ds = \frac{900 \times 13{\cdot}515 \times 10^6}{2{\cdot}103 \times 10^6 \times 2371{\cdot}1} = 2{\cdot}439\ \text{cm.}$$

$$\Delta_{KH}\ (\text{graph}) = \frac{H}{E\,I}\int K_H\,y^2\,ds = \frac{900 \times 44{\cdot}556 \times 10^6}{2{\cdot}103 \times 10^6 \times 2371{\cdot}1} = 8{\cdot}041\ \text{cm.}$$

$$K_H\ (\text{graph}) = \frac{\int K_H\,y^2\,ds}{\int y^2\,ds} = \frac{\Delta_{KH}\ (\text{graph})}{\Delta\ (\text{graph})} = 3{\cdot}298$$

Δ (test) = 10·99 cm.

$$\frac{\Delta\ (\text{test})}{\Delta\ (\text{graph})} = 4{\cdot}507$$

$$\frac{\Delta\ (\text{test})}{\Delta_{KH}\ (\text{graph})} = 1{\cdot}367$$

is obtained from formula (3) and Δ_{KH} (graph) from formula (22).

The ratio of $\frac{\Delta_{KH}\ (\text{graph})}{\Delta\ (\text{graph})}$ is equal to the Karman factor K_H for the complete bend, which for this case is equal to 3·298. The ratio of the test deflection to the theoretical deflection obtained by the graphical method is 4·507. Finally, the ratio of the test deflection to the corrected theoretical deflection obtained by the graphical method is equal to 1·367. It follows,

* No. II. appeared August 24th.

† Uber die Formänderung dünnwandiger Rohre, insbesondere federnder Ausgleichrohre. *Zeitschrift des Vereines deutscher Ingenieure.* Vol. 55, No. 45, page 1889.

‡ "Die Biegung krummer Rohre." *Dingler's Polyt. Journal,* 1912. Vol. 327, page 577; also *Technische Elastizitätslehre,* 1913, page 310.

therefore, that the test deflection is 36·7 per cent. higher than the corrected theoretical deflection, according to Karman.

The ratio of the test deflection to the Karman deflection by the graphical method using the Karman factor, and applying thrusts of 300 kilos., 600 kilos. and 900 kilos., is 1·287, 1·298 and 1·367 respectively. The average ratio is therefore 1·317, so that the test deflection is 31·7 per cent. greater than the Karman deflection—Table XI.

TABLE XI.—*200 mm. Lyre Bend (Bantlin). The Ratio of the Test Deflection to the Deflection Obtained by the Graph Method, using the Karman Factor for Varying Thrust.*

1	2		3	4	5
			Thrust in kilos.		
			300.	600.	900.
1	Δ (graph), cm.		0·813	1·626	2·439
2	Δ_{KH} (graph), cm.		2·68	5·36	8·041
3	Δ (test), cm.		3·45	6·955	10·99
4	K_H (graph)		3·298	3·298	3·298
5	$\frac{\Delta \text{ (test)}}{\Delta_{KH} \text{ (graph)}}$	Actual	1·287	1·298	1·367
		Average	1·317		

(*b*) 125 *mm. Bantlin Lyre Bend.*—This bend was examined by the graphical method, and Fig. 20 shows the actual mean shape—full line—and the mathematical mean curvature assumed by Bantlin

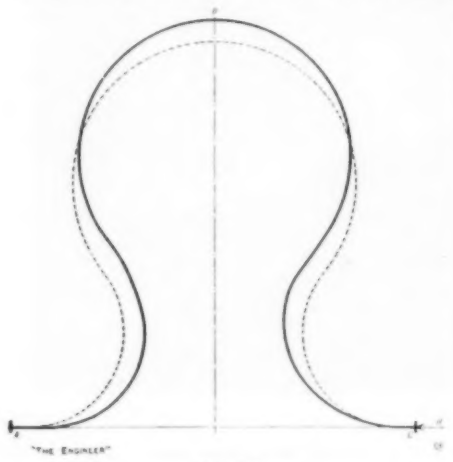


FIG. 20

—dotted line—for the calculation of the theoretical deflection. The particulars obtained by the graphical method are given in Table XII. It is found that the Karman factor is equal to 1·964, and that the ratio

TABLE XII.—*125 mm. Lyre Bend (Bantlin). Particulars Obtained by Graphical Method of Determining the Deflection for the Actual Shape of the Bend and Using the Karman Deflection-Thrust Correction Factor.*

d_1 .. .. 13·3 cm.
d .. .. 12·46 cm.
r .. .. 6·44 cm.
δ .. .. 0·412 cm.
H .. .. 200 kilos.
E .. .. $2·103 \times 10^6$ kilos. /cm.^{2}
I .. .. 352·07 cm.^{4}
$\int y^2 ds$ .. .. $11·754 \times 10^6$ cm.^{3}
$\int K_H y^2 ds$ .. .. $23·067 \times 10^6$ cm.^{3}

$$\Delta \text{ (graph)} = \frac{H}{E\,I} \int y^2 ds = \frac{200 \times 11·753 \times 10^6}{2·103 \times 10^6 \times 352·07} = 3·25 \text{ cm.}$$

$$\Delta_{KH} \text{ (graph)} = \frac{H}{E\,I} \int K_H y^2 ds = \frac{200 \times 23·067 \times 10^6}{2·103 \times 10^6 \times 352·07} = 6·38 \text{ cm.}$$

$$K_H \text{ (graph)} = \frac{\int K_H y^2 ds}{\int y^2 ds} = \frac{\Delta_{KH} \text{ (graph)}}{\Delta \text{ (graph)}} = 1·964$$

Δ (test) = 7·2 cm.

$$\frac{\Delta \text{ (test)}}{\Delta \text{ (graph)}} = 2·125$$

$$\frac{\Delta \text{ (test)}}{\Delta_{KH} \text{ (graph)}} = 1·128$$

of the test deflection to the theoretical deflection is equal to 2·125, and that of the test deflection to the Karman deflection is equal to 1·128. Thus the test deflection is 12·8 per cent. greater than the Karman deflection.

(4) COMPARISON OF KARMAN DEFLECTION-THRUST CORRECTION FACTOR WITH RATIO OF TEST TO THEORETICAL DEFLECTION.

(*a*) *Mild Steel Expansion U Bends (Table XIII.).*—The Karman factor was determined for the Crocker and Sanford and the Hovgaard tests—see Tables VII. and VIII. The results are given in Table XIII., in which Col. 12 shows the test ratios.

The ratio of the test ratio to the Karman deflection-thrust correction factor is given in Col. 13. It varies from 0·6481 to 1·0198.

(*b*) *Mild Steel Lyre-shaped Bend.*—Items 1 and 2 of Table XIV. refer to the 200 mm. and 125 mm. lyre-shaped bends. The Karman factor and the test ratio were determined by the graphical method. For items 3, 4, and 5 of this table the Karman factor K_H was obtained as a ratio of the value calculated by formula (23), using the Karman factors K_{H_1} and K_{H_2}, to the theoretical value obtained by formula (12). The average Karman factor K_H is given in Col. 16, and is slightly larger than K_{H_1}. The test ratio is given in Col. 17, and the ratio of the test ratio to the Karman factor is given in Col. 18. We find that the ratio of the test deflection to the Karman deflection varies from 0·741 to 1·367.

TABLE XIII.—*Comparison of the Karman Deflection-Thrust Correction Factor (Col. 11) with the Test Ratio of the Actual to the Theoretical Deflection Thrust Factor (Col. 12). For Mild Steel Expansion U-Bends.*

1	2	3	4	5	6	7	8	9	10	11	12	13
Item	Test by.	Reference, Table/Item	Bore d.	O.S. diam. d_1.	Wall thickness δ.	r.	R.	$\lambda = \frac{R}{d}$	$\varphi = \frac{\delta R}{r^2}$	K_H.	Test ratio $\frac{C_H \text{ (test)}}{C_H \text{ (theor.)}}$	Test ratio $\frac{}{K_H}$
			In.	In.	In.	In.	In.					
1	Hovgaard	VIII./1	4·49	4·724	0·1175	2·3035	12·8	2·85	0·2834	5·582	5·377	0·9635
2	Crocker and Sanford	VII./5	10·0	10·672	0·336	5·168	60·0	6·0	0·7535	2·164	2·207	1·0198
3		VII./1	6·0	6·540	0·270	3·135	39·0	5·0	0·8243	1·992	1·493	0·7495
4		VII./2	6·0	6·548	0·274	3·137	39·0	5·0	0·8353	1·967	1·791	0·9105
5		VII./3	6·0	6·570	0·285	3·142	39·0	5·0	0·8662	1·906	1·275	0·669
6		VII./6	3·25	3·490	0·120	1·685	27·0	8·31	1·141	1·543	1·000	0·6481
7		VII./4	6·0	6·836	0·418	3·209	36·0	6·0	1·462	1·339	1·000	0·7469

The author shows a curve, based on the published tests, which agrees more closely with all the test values than the Karman or Lorenz curves do. He proposes that this curve should be used, and hopes that in the near future tests may be made for pipe factors equal to 1·0 to 2·0 in order to confirm the fact that over this range the test curve lies below the Karman and Lorenz theoretical curves. It is to be hoped that some British pipe manufacturer will carry out tests on pipe bends for pipe factors equal to 0·5, 1·0, 1·5 and 2·0, and publish the information, in order to assist engineers in the design of expansion bends.

(5) GRAPHICAL REPRESENTATION OF THE KARMAN, LORENZ AND AUTHOR'S DEFLECTION-THRUST CORRECTION FACTOR FOR MILD STEEL BENDS.

For the pipe designer who wishes to make use of this series of experiments and the data summarised in Tables XII. and XIII., it is necessary to represent the test values graphically by plotting them for varying values of the pipe factor. For this purpose all the test ratios for expansion U bends—Table XIII., Col. 12—and the lyre-shaped bends—Table XIV., Col. 17—are plotted in Fig. 21 as a function of the pipe factor. For expansion U bends the pipe factor in Col. 10, Table XIII., has been used. For the lyre-shaped bends, which have a varying pipe factor, the average pipe factor corresponding to the average Karman factor K_H—Table XIV., Col. 16—has been used. Fig. 21 shows the test ratios, together with the Karman and Lorenz factors.

Examining the test points, we find that:—(*a*) Bantlin's test values agree very closely with the Lorenz curve; (*b*) Hovgaard's test values agree very closely with the Karman curve; (*c*) Crocker and Sanford's test values are considerably below the Karman and Lorenz curves; (*d*) Hovgaard's test point—XIV., 3—agrees very closely with the Lorenz factor; (*e*) test point XIII., 2—Crocker and Sanford—corresponds very closely to the Karman factor.

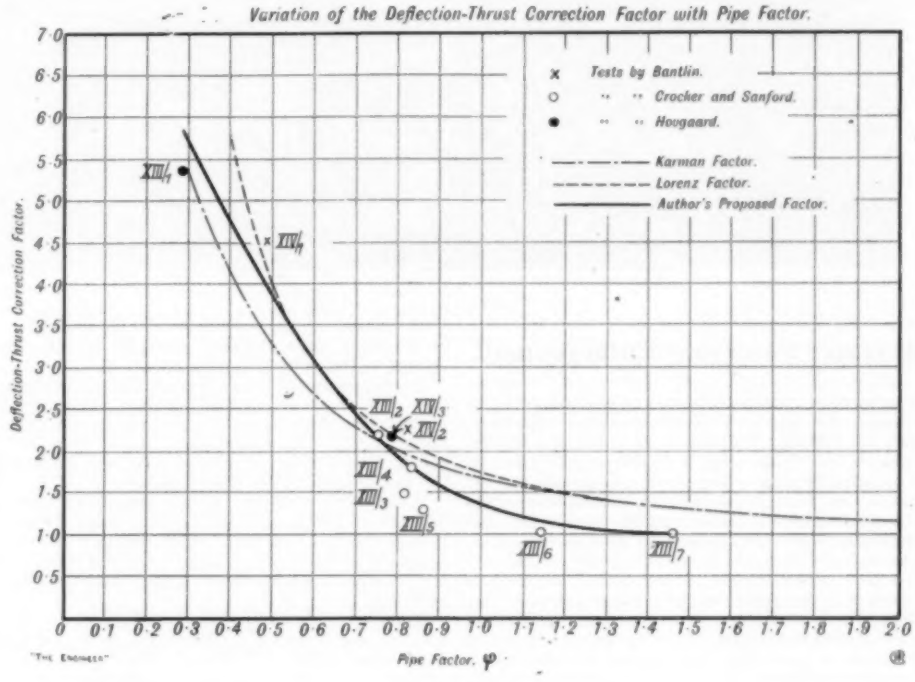


FIG. 21

TABLE XIV.—*Comparison of the Karman Deflection-Thrust Correction Factor (Col. 16) with the Test Ratio of the Actual to the Theoretical Deflection Thrust Factor (Col. 17). For Mild Steel Lyre-shaped Bends.*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Item.	Test by.	Reference Table/Item	Bore d.	O.S. diam. d_1.	Wall thickness δ.	r.	R_1.	R_2.	$\lambda_1 = \frac{R_1}{d}$	$\lambda_2 = \frac{R_2}{d}$	Pipe factor.		Karman Factor.			Test ratio $\frac{C_H \text{ (test)}}{C_H \text{ (theor.)}}$	Test ratio $\frac{}{K_H}$
											φ_1.	φ_2.	K_{H_1}.	K_{H_2}.	K_H.		
			In.	In.	In.	In.	In.	In.									
1	Bantlin ..	V./3	Graphical method for actual shape of bend—Fig. 19, Tables X. and XI.												3·298	4·507	1·367
2	Bantlin ..	V./4	Graphical method for actual shape of bend—Fig. 20, Table XII.												1·964	2·215	1·128
3	Hovgaard ..	VIII./2	6·127	6·656	0·2646	3·196	30·31	29·57	4·945	4·826	0·7847	0·7664	2·072	2·121	2·076	2·196	1·058
4	Crocker and	VII./8	6·000	6·82	0·410	3·205	36·00	36·00	8·000	8·000	1·437	1·437	1·35	1·35	1·35	1·00	0·741
5	Sanford ..	VII./7	4·000	4·474	0·237	2·118	28·00	28·00	7·000	7·000	1·480	1·480	1·331	1·331	1·331	1·02	0·7663

(To be continued.)

A PLATE of stainless steel has been exposed on the promenade deck of a Blue Star liner during a six weeks' voyage, and, although it was not touched during all that time, it is said to show no signs of tarnish and to be as bright as when originally placed in position.

BURRATOR RESERVOIR SHOWING HEIGHTENED DAM

MR. FRANK HOWARTH, M. Inst. C.E., PLYMOUTH, ENGINEER

Burrator Reservoir Enlargement.

The work of raising the water level—and hence of increasing the capacity—of the Burrator Reservoir, which the Water Engineer's Department of the Plymouth Corporation has been carrying out, is now completed. The enlargement has been effected by direct labour from the designs and under the supervision of Mr. Frank Howarth, M. Inst. C.E., the Corporation Water Engineer, and to him we are indebted for the particulars contained in what follows.

We have several times referred to this work while it has been in progress, and our readers will remember that the reservoir is formed by two dams, one called the Burrator Dam, which is built of granite masonry and concrete, and the other called the Sheepstor Dam, which consists of an earth embankment with a puddle wall above the original ground level, and a concrete tongue below ground level.

The lists below give a comparison between the dams before and after the alterations :—

	As originally constructed.	After enlargement.
Storage capacity	668 million gals.	1026 million gals.
Top water area	117 acres	148 acres.
Greatest depth of water	77ft.	87ft.
Top water level	708·00 O.D.	718·00 O.D.
Burrator Dam—		
Length of dam	417ft.	452ft.
Length of overflow ..	125ft.	125ft.
Thickness (bottom) ..	64ft.	64ft.
Height (foundation to coping of bridge) ..	145ft. 6in.	153ft. 6in.
Sheepstor Dam—		
Height of embankment ..	23ft.	33ft.
Width at top	12ft.	16ft.
Slopes, inner 3 to 1, outer 2 to 1		Inner 3 to 1, outer 2½ to 1.
Greatest depth of trench	105ft.	Greatest depth of extended trench 92ft.
Length of trench	700ft.	978ft.
Length of embankment	450ft.	650ft.

In carrying out the work the bridge conveying the road over the Burrator Dam and a considerable portion of the dam itself had to be taken down. The outer profile of the dam was then continued to the required height and curved to meet the sill at the new overflow level, which is 10ft. above the original sill. The remainder of the dam was raised to the new height and carried into rock in the hillsides at each end. The new bridge, which is of granite and consists of five segmental arches each having a span of 25ft. and a rise of 7ft. 6in., was then rebuilt, the approach roads being raised to the level of the new road over the dam. The width of the road between the parapets is 18ft.

A suspension bridge, 400ft. span between the towers, was placed across the reservoir for general traffic and transport of material required on the work. This bridge, which is seen in our illustration, will be removed when the road over the dam is finally opened to the public.

At the Sheepstor Dam the top 5ft. of puddle were first of all removed, worked up and replaced. New puddle was then carried to 3ft. above the new top water level. Junctions were made with the old concrete tongue below ground level and carried into the hill at each end in wing trenches.

With these trenches great difficulties were encountered, the length at one end being 300ft. and the greatest depth 92ft. The trenches were close timbered and a large quantity of water was encountered, which necessitated heavy and continuous pumping.

Hutments lighted by electricity by a hydro-electric plant were erected for the workmen, each man having a separate sleeping cubicle. Baths were installed as were also a drying-room and ablution sheds.

The works have been in progress 4½ years, and are now completed, with the exception of a short piece of approach road to the masonry dam.

Apparatus and Methods for Measurement of the Hertzian Hardness.

By R. ESNAULT-PELTERIE.

(*Concluded from page* 197.)

The author naturally took the precaution of making several diametral measurements and taking the mean, but unfortunately this precaution makes the method still slower, more tiresome and particularly fatiguing to the eyes.

It then appeared to the author that a method of measurement of not merely one or more diameters of the area of contact, but of the area of contact itself, would have considerable advantages, the diameter of the equivalent circle being obtained as the square root of the product of this area multiplied by $4/\pi$.

Method Adopted.—The method adopted consists in measuring the electrical resistance to the passage of a current through the point of contact of the two balls. The theory of the electric resistance of two conductive bodies in contact justifies this method, as will now be shown.

Let us assume an indefinite space filled with homogeneous material of an isotropic resistivity ρ divided into two portions A and B by an unlimited plane, giving perfect insulation between the two portions. An opening C in this plane puts the two spaces A and B into electric connection.

Let us assume also that a current of ampèrage I passes from an infinite distance on the side A to an infinite distance on the side B through the opening C which connects the two sides of the plane just mentioned. Now let there be in the space A an equipotential surface of the potential U_1, and in the space B an equipotential surface of the potential U_2.

Let the definition of electric resistance between these two equipotential surfaces be represented by

$$R_A + R_B = \frac{U_1 - U_2}{I} \quad . \quad . \quad . \quad (20)$$

The calculation of this resistance requires that the equipotential surfaces and the lines of current in the conducting space should be known.

In each of the spaces A and B one of the equipotential surfaces is known by reason of its symmetry. This is the hemisphere of infinite radius having its centre in the opening C.

The other equipotential surface is also, by reason of symmetry, the surface of contact itself which is a plane.

If, in the case in which the surface of contact is a circle, a family of surfaces that comprise both these particular surfaces is sought, it is found that one of them is formed by an oblate ellipsoid (E), of which the generating ellipses have as foci the extremities of the diameter of the contact circle, and as axis of revolution the normal to the plane of the circle of contact through the centre of that circle.

The lines of current, which at every point must be normal to each of the equipotential ellipsoids, will then be hyperbolæ (H) homofocal with the generating ellipses of the ellipsoids.

As this system has been arbitrarily selected, it will, of course, be necessary to ascertain whether it will have the properties of equipotential surfaces and of the lines of current ; that is to say, whether it is compatible with the laws of the propagation of electricity. It will be found that this is the case.

The resistance at the point of contact of the two spaces A and B between the hemispheres of infinite radius will be represented by the expression (20).

In order that this definition may have a meaning, it is, of course, necessary that the expression (20) should tend towards a limit when the dimensions of the equipotential surfaces under consideration tend towards the infinite. It will be seen that this condition is also fulfilled, as had been foreseen.

Calculation of the Theoretical Resistance of the Contact Defined Above.—Taking as a triple system of co-ordinated surfaces, first, that of the homofocal ellipsoids (E) ; secondly, that of the hyperboloids of one sheet having as their generatrices the hyperbolæ (H) ; and thirdly, the sheaf of planes passing through the normal axis at the centre of the contact circle.

In this system each ellipsoid, each hyperboloid

and each plane is respectively defined by one of the equations—

λ = a const. (21), γ = a const. (22), θ = a const. (23),

where λ represents the square on half the minor axis of the ellipsoid (E), γ that of the imaginary semi-diameter of the hyperbola (H), and θ the angle which one of the planes of the sheaf makes with the plane selected as the origin. We then have for the Laplacian of any function φ of the co-ordinates

$$\Delta\varphi = \frac{4c\sqrt{\lambda\gamma}}{\lambda+\gamma}\left\{\frac{\partial}{\partial\lambda}\left(\frac{c^2+\lambda}{c}\sqrt{\frac{\lambda}{\gamma}}\frac{\partial\varphi}{\partial\lambda}\right)+\frac{\partial}{\partial\gamma}\left(\frac{c^2-\gamma}{c}\sqrt{\frac{\gamma}{\lambda}}\frac{\partial\varphi}{\partial\gamma}\right)+\frac{c}{4}\frac{\lambda+\gamma}{(c^2+\lambda)(c^2-\gamma)\sqrt{\lambda\gamma}}\frac{\partial^2\varphi}{\partial\theta^2}\right\} \quad . \quad (24)$$

In order that the ellipsoids (E) may act as equi-potential surfaces under constant flow, it is necessary and it is sufficient that the potential V should simultaneously satisfy the equations

$$\Delta V = 0\,, \quad \frac{\partial V}{\partial\gamma} = 0\,, \quad \frac{\partial V}{\partial\theta} = 0\,, \quad . \quad (25)$$

That is to say—

$$(c^2+\lambda)\sqrt{\lambda}\frac{dV}{d\lambda} = A\,, \quad . \quad . \quad . \quad . \quad (26)$$

where A is a constant.

The current density at each point is

$$J = \frac{2A}{\rho\sqrt{(c^2+\lambda)(\lambda+\gamma)}} \quad . \quad . \quad (27)$$

The element of current in a tube of streamlines having as its base

$$dS = \frac{1}{2c}\sqrt{\frac{(\lambda+\gamma)(c^2+\lambda)}{\gamma}}\,d\gamma\,.\,d\theta \quad . \quad (28)$$

will be

$$dI = \frac{A}{\rho c}\frac{d\gamma}{\sqrt{\gamma}}\,d\theta \quad . \quad . \quad . \quad (29)$$

which by integration extended to the semi-ellipsoid gives for the total current—

$$I = -4\pi\frac{A}{\rho} \quad . \quad . \quad . \quad . \quad . \quad (30)$$

whence

$$dR = \frac{dV}{I} = \frac{\rho}{4\pi}\frac{d\lambda}{(c^2+\lambda)\sqrt{\lambda}} \quad . \quad . \quad (31)$$

and integrating from λ_1 to λ_2

$$R_{\lambda_1}^{\lambda_2} = \frac{\rho}{2\pi c}\left[\arctan\frac{\sqrt{\lambda_2}}{c} - \arctan\frac{\sqrt{\lambda_1}}{c}\right] \quad . \quad (32)$$

This integration being effected between $-\infty$ and $+\infty$ gives

$$R_{-\infty}^{+\infty} = \frac{\rho}{2c} \quad . \quad . \quad . \quad . \quad . \quad (33)$$

which shows that the resistance due to throttling is inversely proportional to the diameter of the contact circle.

Note.—(1) This resistance can be written

$$R_{-\infty}^{+\infty} = \rho\frac{\frac{\pi}{4}2c}{\pi c^2} \quad . \quad . \quad . \quad . \quad (34)$$

showing that it is equal to that of a cylinder of the same resistivity as the material under consideration, of a diameter equal to that of the orifice and of a length slightly less than its diameter.

(2) This observation shows to what extent the resistance is localised in the vicinity of the orifice. If, however, it is desired to see how R varies when the distance from the orifice increases, λ_1 must be made equal to zero, and (32) becomes

$$R_0^{\lambda_2} = \frac{\rho}{2\pi c}\arctan\frac{\sqrt{\lambda_2}}{c} \quad . \quad . \quad (35)$$

Going back now to equation (21), we see that $\sqrt{\lambda_2}$ is the polar radius of the ellipsoid under consideration. Supposing this radius to be equal to 20 c—that is to say, only to ten times the diameter of the contact circle—the resistance will then be equal to 0·968 R_{lim}.

This shows clearly that the assumption that the author had made relating to the contact between the spheres and its similarity to contact between two planes is a legitimate assumption in practice.

To sum up, if we consider two balls of the same diameter D in contact with each other, the diameter of the circle of contact d varying from 1/50 to 1/20 ot D, it will be seen that the resistance between two equatorial planes parallel to the plane of contact cannot differ greatly from the above calculated limit. Actually, two causes tend to produce change in the inverse sense.

The one by reducing it in consequence of the finite distance of the planes under consideration; the other by increasing it in consequence of the smaller increase of the equipotential surfaces starting from the circle of contact in the case of the two spheres.

Order of Magnitude of the Resistance.—When it is a question of treated steels, we may take

$$\rho = 15\times10^{-6}\ \Omega\ \text{cm.}^3$$

it being possible to consider this value as a reasonable mean and giving

for $d = 0{\cdot}05$ cm. $\quad R_{-\infty}^{+\infty} = \frac{15}{0{\cdot}05}\cdot10^{-6} = 0{\cdot}0003\ \Omega$

for $d = 0{\cdot}10$ cm., $\quad R_{-\infty}^{+\infty} = \frac{15}{0{\cdot}1}\cdot10^{-6} = 0{\cdot}00015\ \Omega$

that is, a conductance of the order of

3000 to 6000 mhos.

Practical Conditions for the Measurements.—The resistance to contact of two balls tends, of course, according to the conditions under which the experiment is varied, either in dimension of the balls or in character of the metal used, to take values appreciably different from these and particularly values that are much smaller. Amongst the methods that enable such small resistances to be measured, the Thomson double bridge was chosen as being the most practical. It permits of making measurements to $10^{-6}\ \Omega$

It can be understood that no pretension can be made to measure such a resistance by itself, and there are unavoidable additional resistances which, however small they may be, increase appreciably the total resistance measured on account of the small magnitude of the contact itself. It is not actually possible, therefore, to hope to determine with precision anything more than the variations of the latter and not its absolute value.

This disadvantage, moreover, is not the most troublesome, and a much greater difficulty arises from the phenomena which take place at the surface of contact of the two balls.

In the calculation of which the summary appears above, the conducting medium has been considered as entirely homogeneous and continuous, even through the orifice S, whereas actually the contiguous molecules which belong respectively to the two balls, although they are pressed together, are not in a relative condition that is comparable with that of two adjacent molecular layers of a solid metallic block.

In practice, the phenomena that result in this intermediate layer have often proved rather troublesome and irregular, notwithstanding the precautions taken to eliminate all traces of oxide from the surface of the metal.

In the first instance an attempt was made to suppress all traces of oil, but in practice it was found that it was an advantage to leave an oil film, and so far from increasing the resistance this had the effect of decreasing it.

Another difficulty then presented itself, the resistance, as had been seen, is localised in the vicinity of the point of contact, and the author's experiments would be made to a great extent on nitrogen-treated balls, and also on case-hardened balls. The resistivity of such bodies probably varied between large limits from the surface to a depth of 1 mm. or 2 mm.; that is to say, in the zone in which the resistance is localised. It was impossible, under these conditions, to hope to determine the diameter of contact directly by these electrical measurements because it was the resistivity of the material which varied from one point to another.

Mode of Application of this Method.—The conditions that have been shown above enable one to understand that it is impossible to expect from this process anything else than a curve of values of total resistances measured as functions of successive loads applied to the balls, and this only on the condition that the secondary resistances, to which allusion has been made above, should be rendered sufficiently constant, or, if necessary, that they should vary regularly. The form of curve obtained should then reproduce that of the true curve for the theoretical resistance defined above, and particularly show the cusps in the curve.

Actually, what led to the adoption of this method was that the whole of the points determined by the first method always required some interpretation for the curve drawn.

The basic object of the search was to obtain points arranged sufficiently closely for the plotting of the curve not to require any interpretation, and that, in particular, the points of change of curve should be shown clearly, thus giving accurately the total load corresponding to the elastic limit of the balls.

If, by using another method, we determine the cubic parabola representing the diameters of the contact circle as a function of the total load, we then have from Hertz's formulæ the tensile breaking strength of the metal w_{max} from formula (3)—

$$w_{max} = 1{\cdot}9095\frac{F}{d^2} \quad . \quad . \quad . \quad (3)$$

These various considerations led to the conception of the following method:—

The electric resistance of the test balls is, in the first instance, measured under increasing loads, and by this means the cusps are obtained on the curve $R = f(F)$ with precision.

This being laid down and the points of contact of the balls having been changed, they are subjected to the old method of silver-plating and loaded with increasing loads F_1, F_2, F_3 . . . but always appreciably less than the breaking load given by the electric method.

Generally, and in proportion to the imperfect finish of the small number of test balls, as has been stated, the contact circles obtained are somewhat irregular, and the values obtained by these different methods of measurement used in the formulæ of Hertz give different values for the modulus of elasticity $\mathcal{E}$. Taking the mean of these different values, a figure is obtained which, for the greater number of the steels on which the author has made his experiments, differs very little from $2{\cdot}1\times10^6$ kilos. per square centimetre; that is 20,000 kilos. per square millimetre.

If this value is introduced into Hertz's formulæ (1b) and (3), and F replaced by the value corresponding to the breaking load, the Hertzian elastic limit of the metal is obtained from the equation

$$w_{max} = 0{\cdot}616\times\mathcal{E}^{\frac{1}{3}}F^{\frac{1}{3}} \quad . \quad . \quad . \quad (3A)$$

Simplification of the Determination of $\mathcal{E}$.—The delicate character of the silver coating of the balls having already led to the conception of this electrical method, the author naturally sought to avoid the recurrence of the same difficulty in the measurement of $\mathcal{E}$, and to do this he devised the following method:

Given a class of materials that are being subjected to experiment, it is possible to determine, on the one hand, by the silvering method, the law of variation of diameters of the actual contact d as a function of the total loads applied, and, on the other hand, to determine the same law of variation for the diameters of the apparent contacts d_1 such as are obtained by direct observation of the surface of contact of the two balls examined by the microscope over the edges.

Two luminous cusps are visible in the field of the microscope and the measure of the distance between their vertices gives the measurement of the "apparent" diameter (d_1) of the circle of contact.

Such diameters are always larger than the real diameters of contact d, because the visible light is subject to interferences and cannot pass tangentially between the surfaces of the two balls in the zone, where they are too close to each other. This applies to distances that are sensibly greater than the thickness of the silver coating.

These apparent diameters d_1 have, however, just as accurately determined values in relation to the true diameters d, and if the one class of observations is plotted as abscissæ and the other class as ordinates, they follow a very nearly straight line, which appears to vary but little from one material to another.

Under these conditions, it is possible to substitute the measurements of d_1 for those of d, and to obtain the latter from the former by means of a similar rectilinear curve previously determined. For the same class of material, and probably even for all elastic materials, the determination of the Hertzian coefficient of elasticity, $\mathcal{E}$ may be obtained by simple microscopic readings, provided that one set of measurements by the silver-plating method has been made.

Theoretically, the relationship between d_1 and d should be independent of the material of which the balls are made.

Results.—As soon as the apparatus devised had been constructed, the author naturally submitted it immediately, as a check, to measuring the breaking loads of commercial balls of the same quality as those which he had measured previously by the first method. A series of twenty-nine measurements thus made confirmed in very satisfactory terms the results of the author's previous research, but showed him much more clearly the large accidental variations in the resistance to fracture of these balls between different points on the surface of the same ball.

The author then submitted the various specimens of nitrogen-treated steels and case-hardened steels to the same tests.

In order that the progress made may be rendered available, four curves are given below—Fig. 9—in which the abscissæ represent the total pressures applied and the ordinates represent the corresponding measurements of the conductance. The accuracy with which the points fall in each case on a curve consisting of successive festoons meeting in cusps is quite striking, and in the case of this electrical method the curve requires no "fairing." One of the curves shows a break of continuity at a point A. This break occurred at a time when the scale was changed on the electrical measuring apparatus, and consequently it may be disregarded.

On the diagram—Fig. 9—two of Hertz's cubic

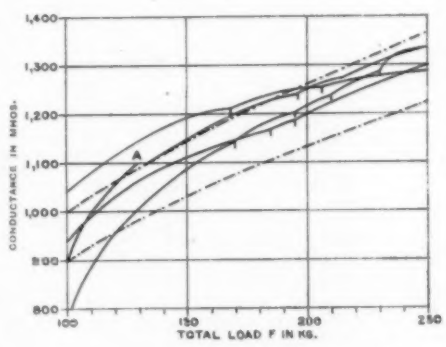


FIG. 9

parabolæ are shown in dot-and-dash lines, and although each curve, taken by itself, differs sensibly from these parabolæ, it can be clearly seen that, taken as a group, they have the same form, and this appears to justify the law based on theory that is propounded above—equation (33).

The Table VI. that follows gives some of the total breaking loads in kilogrammes and the correspond-

ing values of the Hertzian hardness in kilogrammes per square millimetre for the different steels tested.

TABLE VI.

Quality of steel tested.	Total breaking load, balls 20 mm. dia.	Pressure at the centre of the area of contact at the moment when fracture took place = Hertzian hardness
	Kilos.	Kilos. per sq. mm.
Good commercial balls	65	393
Case-hardened steel, very hard	93	441
Nitrogen-treated steel—No. 2	94	444
No. 3	165	536
No. 5	186	577

The number of curves obtained is not as yet very large, but it exceeds fifty already, which represents more than 1500 measurements, and although it is certain that many details are capable of being improved, it appears that in general the method has been made practical and is capable of being applied to the making of tests for manufacturers of steels or of ball bearings.

A Large Vacuum Paper Dryer.

ONE of the most interesting of recent additions to the equipment in the newsprint plant of Price Brothers and Co., Ltd., at Kenogami, Quebec, is a Minton vacuum paper machine dryer. This dryer, which has been installed on the company's No. 1 machine, contains twenty dryers, 5ft. in diameter, with a face of 152in. The machine, which is shown partially constructed and completely assembled in the makers' works, in the views on page 223, and is seen in operation in the paper works in the accompanying engraving, Fig. 1, was built at the works of Charles Walmsley and Co. (Canada), Ltd., at Longueuil, Quebec. To the dryer was attached a suitable condenser, dry vacuum pump, air cooler, &c. This vacuum dryer is now in regular twenty-four-hour operation, working at a speed of 700ft. per minute, drying standard newsprint paper. It was the first vacuum dryer to be used for drying newsprint, and is much the largest hitherto constructed. Prior to the installation of this machine, there was little or no information as to what might be expected from it, from an operating standpoint, though there was a good deal of experimental data available, and much also in the form of theoretical considerations. Before then there had not been any vacuum dryer operated at a speed in excess of about 200ft. per minute, or any that had taken paper direct from the last wet press of a paper machine and dried it. There was much doubt in the minds of many of the best paper mill engineers as to the results to be obtained, and there was considerable apprehension as to whether the parts of so large a piece of machinery would be correctly designed in the first large size machine.

The casing of the dryer was built up of cast iron plates, extensively ribbed for strength. Where they were bolted together the surfaces were planed, the surfaces being then covered with a thick mixture of white lead and machine oil to make air-tight joints. The castings were made of semi-steel, and care was taken to get it as close grained and free from blow or pin holes as possible.

In designing the various castings, a liberal factor of safety was used in each case. All of the castings were dowelled together with steel dowel pins, as well as bolted, so that it might be possible to remove any casting and replace it and with the assurance that the parts would go together again, just as they came apart. The entire casing was made sectional, and of standardised sections, so that dryers could be added to or taken from it, should the need ever come. Doors and windows were arranged where they would be of most use and fitted with special gaskets and in some cases hinged so that they could be quickly opened and closed. Openings were left for the felt-carrying rolls, so that they may readily be unbolted and pulled out the front of the dryer. These felt-carrying rolls were also mounted on roller bearings and their housings were dowelled with steel pins to the main side castings, to make certain that the rolls would be parallel with the dryers, and, if removed for any reason, must of necessity go back in exactly the same position.

The dowel pins locating these rolls were made with a threaded end and a nut, so that they might be quickly and easily removed. In fact, this type of dowel pin has been used throughout the whole vacuum dryer. The rear bearings of the felt-carrying rolls are held in place by the housing, but the front bearings are left free to slip, so as to permit of contraction and expansion, just as was done in the case of the bearings on the dryer journals. The housings are filled with oil to a predetermined level, and will run for a very long time without attention of any kind. The bearings themselves are of the "S K F" self-aligning roller type, and extra-large bearings were used to insure long life and freedom from bearing troubles. The housings, however, are so designed and attached to the main casting that, should bearing trouble arise, the bearings can quickly and easily be removed and new bearings substituted. Doors at the dry end of the machine have been conveniently arranged for putting on dryer felts. Automatic felt stretches of conventional type, hand guide and Moore and White automatic felt guides are used to guide and stretch the dryer felt.

It was decided for various reasons to install roller bearings on all the rolls contained in this dryer. Heretofore, engineers have hesitated about installing ball or roller bearings on the dryer journals, because of the high temperatures attained, especially the rear dryer journal, which is hollow, and through which the steam is fed into the dryer. Nevertheless, after careful consideration, it was decided to use roller bearings, and a bearing was selected, though, as has been said, its capacity was considerably greater than that actually necessary to carry the load. The size of the journal was, of necessity, large in order to give sufficient area for the steam inlet through the rear journal, and that in reality settled the size of the bearing that would have to be used. For the sake of standardisation, the front dryer bearings were made the same size as the rear bearings. "S K F" self-aligning roller bearings were selected and the outer races were slightly freed out to allow for expansion. The bearings were fitted to the shafts on taper sleeve split bushings to insure a good tight fit on the shafts, and also to make it easier to take out a bearing, if found necessary. The rear bearings were held in the housings to locate the dryer, but the front bearings were left free to slip in the housings to allow for contraction and expansion of the dryer when heating up or cooling off. This construction also definitely locates the rear shafts, so that the drive unit is not affected by the contraction and expansion of the dryers.

On the rear bearings an automatic lubricating system affords a constant supply of lubricant at all times. The system comprises a small pump that raises the oil to a tank on top of the dryer, from which it runs to the stuffing-boxes on the rear dryer journals and into a spacer ring set between the packing rings which makes an oil seal for the stuffing-box, keeps the packing rings always lubricated, and the oil leaking into the vacuum runs directly into the roller bearings. At the correct height in the bearing housing there is a small overflow drain, through which the oil runs back to a tank under the dryer, and is taken by the pump back to the feeding tank on the top of the dryer. A filter is also included in the system to remove impurities or foreign matter from the oil. The front dryer bearings merely have a constant level of oil in which they run, and the arrangements are such that these bearings must always be filled to just the correct height.

One of the problems was to determine the correct kind of oil to use. The makers of the bearings specified a long list of things that this oil should not contain as well as a long list of qualities it should have. Added to this was the fact that the oil would be heated up to the temperature of the steam in the rear dryer journal, and also would be under a considerable vacuum. Yet it was essential that the oil should not lose its lighter components, and thereby have its characteristics changed. Much research was called for, and, after careful consideration of all the requirements, several grades of oil were selected and then tested under the temperature and vacuum conditions till a suitable lubricant was found. The bearings and the oil have now run for a sufficient time to vindicate the selection of this type of bearing and the particular oil chosen. There has not been one minute of lost time due to bearings.

The paper passes into the seal between a rubber-covered roll, and the lower of two bronze-covered rolls. The rubber roll is held tight against the bronze rolls by the pull of the vacuum from within the chamber, thus forming a rolling seal at this point. The surface of the rubber roll, however, gives enough to allow the paper to pass, and yet for a seal against the entry air. The ends of all three rolls are fitted with a special form of sealing ring to exclude air at the ends. The bronze-covered rolls run in roller bearings and are arranged in the main seal casting. In this casting are grooves into which the sealing and wiping rubbers are placed by pulling them through from the front or back of the dryer. The rubber tube is then drawn through and the ends plugged with special plugs, and water is put in the tube to push the sealing and wiping rubber up against the bronze rolls. A pressure of approximately 5 lb. per square inch is maintained in these tubes.

The ingoing and outgoing seals on the vacuum dryer at Kenogami are much the same as the earlier type of

FIG. 1—VACUUM PAPER DRYER IN OPERATION AT KENOGAMI

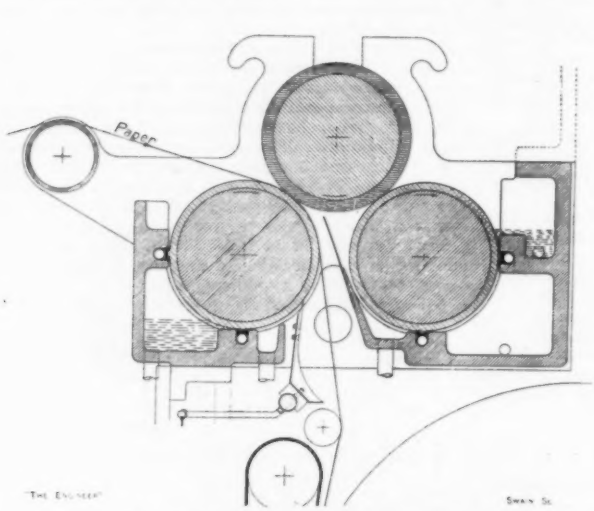


FIG. 2—DIAGRAM OF INGOING SEAL

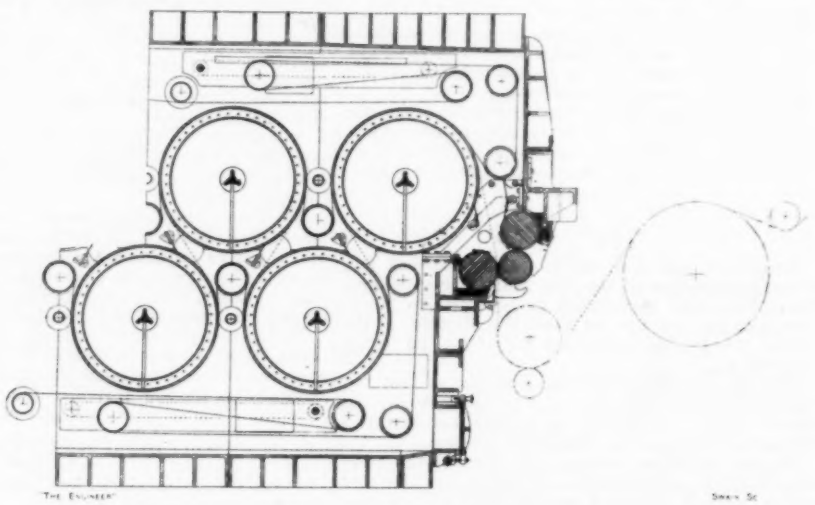
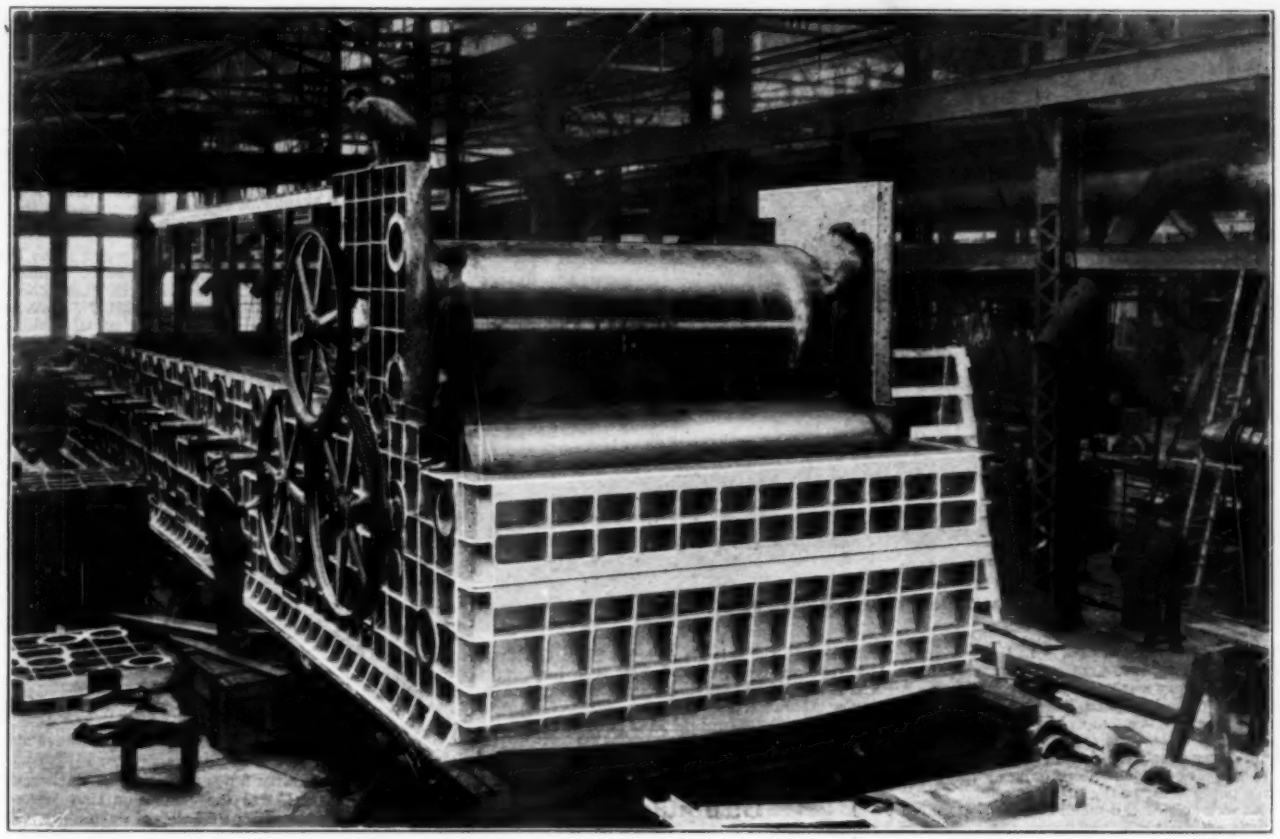


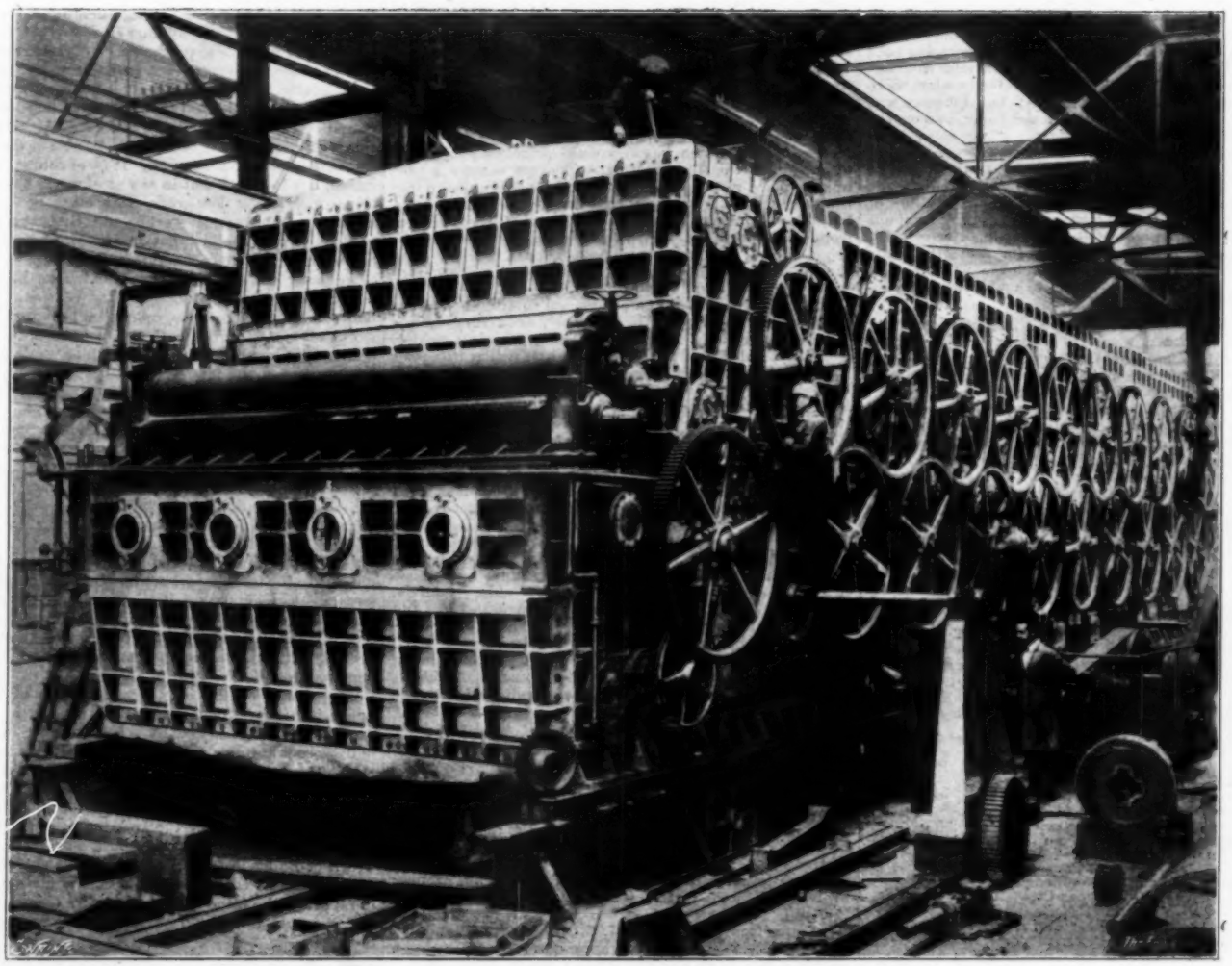
FIG. 3—CROSS SECTION OF OUTGOING SEAL

MINTON VACUUM PAPER DRYER

CHARLES WALMSLEY AND CO. (CANADA), LTD., LONGUEUIL, QUEBEC, ENGINEERS



THE MACHINE PARTLY ASSEMBLED



THE MACHINE FULLY ASSEMBLED

seals used for this purpose. They comprise two bronze-covered rolls, 16in. in diameter, and a rubber-covered roll, 14in. in diameter—Figs. 2 and 3. Unlike the earlier type of seals, however, the ingoing seal has the two bronze rolls set at an angle. This was done to allow the paper to draw into the seal better from the third press felt, and to lower the paper at that point. The outgoing seal likewise has the two bronze rolls set at an angle and also has the rubber roll underneath, thus making what is termed an inverted seal. This was done to improve the passing of the paper around the 24in. sweat dryer and up over the 5ft. sweat dryer and into the calendar stack. This arrangement also eliminated the vertical pass from the last dryer up to the nip between the bronze and rubber-covered seal rolls, which was necessary with the old type of seal. A cross section of the outgoing seal rolls, showing the end-sealing rings and bearings, is given in Fig. 4.

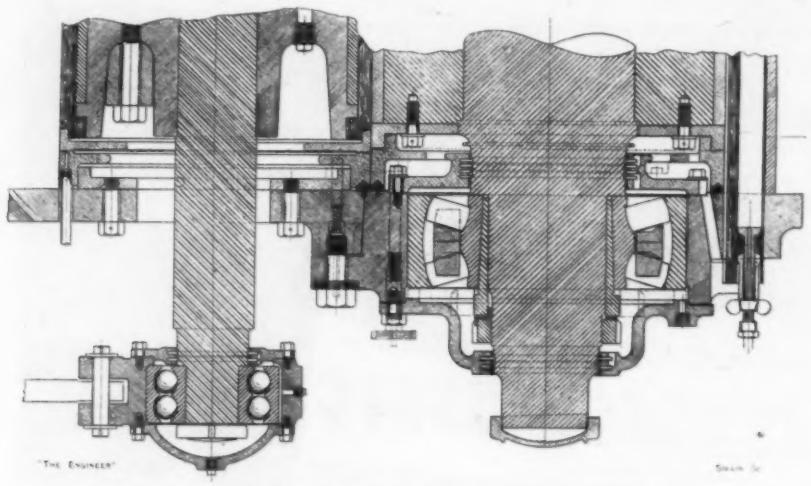


FIG. 4—CROSS SECTION OF OUTGOING SEAL ROLLS

When the vacuum dryer was installed at Kenogami, standard cotton dryer felts were put on and the machine started up. It was a news machine running at 700ft. per minute, and the paper went to the dryer at about 72 per cent. wet. The wet end of the machine was a standard Fourdrinier, with a couch roll, and three wet presses of standard make. The sheet was 148in. wide. No difficulty, other than that a serious wet wrinkle appeared about 12in. in from the front and back edges, was experienced in drying the sheet. The sheet was, however, decidedly damper at the front and back edges than it was in the middle. No reason could be found to cause this condition. Tests of the moisture content of the incoming sheet were taken frequently. At certain times and under certain conditions the wrinkles would just about disappear of their own accord, only to come back again in a few hours' time. Everything any one could possibly think of was tried to correct the trouble, but for a long while without the slightest success. All of the dryers, felt-carrying rolls and seal rolls were checked for alignment, and this was found to be perfect. The felts guided perfectly when there was no paper going over the machine; but difficulty was experienced in guiding them when the paper was on the machine. Rubber-covered automatic guide rolls, however, corrected this. It finally occurred to someone that the difficulty in guiding the felts was due to the fact that the felts were riding on a film of steam, and that that made them hard to guide. If the felts were riding on a film of steam, it was argued, then they were not letting the vapour through, and a more porous felt would help. Accordingly asbestos dryer felts were substituted for the cotton felts and the felts then guided easily and the wet wrinkles disappeared. It was then possible to make the paper on an economic basis.

The condensing equipment used with the vacuum dryer at Kenogami consists of a surface condenser, an air cooler, two dry vacuum pumps and two condensate pumps. Two pumps of each kind were installed, one of each to be held in reserve as a stand-by in case of accident to the other. The surface condenser at the present time is connected in one of the mill lines and the water simply flows through it just as though it was an elbow in the line. The temperature of the water is raised only about 4 deg. Fah. under ordinary working conditions. The installation was intended to be only a temporary arrangement, but it has worked so satisfactorily that it probably will not be changed. The following is a full description of the equipment:—

One Ingersoll-Rand surface condenser, No. 11	
One Ingersoll-Rand air cooler, size C	
Steam capacity, lb. per hour	18,000
Vacuum referred to 30in. barometer	28in.
Designed for circulating water at	70 deg. Fah.
Gallons per minute, circulating water ..	1,500
Water velocity through tubes	7·4ft. per second
Condenser friction in feet of water	15ft.
Condenser water temperature discharge ..	93 deg. Fah.
Square feet of tube surface	1,280
Admiralty metal tubes, 13ft. long, ¾in. O.D. No. 18 B.W.G.	600
Two No. X B Ingersoll-Rand dry vacuum pumps	
These are two-cylinder, double-acting pumps and are belt-driven from a 75 H.P. motor	
Bore	23in.
Stroke	12in.
Rated speed	190 r.p.m.
Capacity, piston displacement	2,188 cub. ft./min.
B.H.P. at pulley for peak intake load ..	82
B.H.P. at pulley for 28in. vacuum	39
The condensate pumps are Cameron pumps, furnished by Ingersoll-Rand and Co.	
Two pumps, No. 2 L V centrifugal condensate pumps	
Capacity, each	27,000 lb. per hour
R.p.m.	1,750
B.H.P.	2·9 each

The dry vacuum pumps have valves so arranged that they can be run at the same time or singly, as also can the condensate pumps. Actually, the dry vacuum pumps are operating at a speed of 144 r.p.m., as there was an error made in getting the pulleys for the motors, and they have not been changed, as it was thought best to run these pumps in at this lower speed. Both vacuum pumps are ordinarily operated together. The air cooler was added to the equipment to reduce the temperature of the air going to the dry vacuum pumps, and thus relieve them of some extra work.

Before the installation of the vacuum dryer, the paper shrank just slightly over 2in. in width in going from the last press to the calendar stack. Since the installation of the vacuum dryer, this shrinkage is just slightly under 1in., or almost exactly one-half of what it was before.

International Conference on Bituminous Coal.

TWELVE major topics for discussion at the Second International Conference on Bituminous Coal, to be held under the auspices of the Carnegie Institute of Technology, Pittsburgh, Pa., from November 19th to 24th next, are tentatively announced by Dr. Thomas S. Baker, President of the Institution, and Chairman of the Congress. About one hundred engineers and scientists representing fifteen nations have already tentatively accepted invitations to speak or to send papers to the Congress, and about 60 per cent. of the papers will be delivered by representatives of countries other than the United States.

Although the Second International Conference will be similar in purpose to the first Congress, which was held in 1926, preliminary plans for this year's meeting show that its scope will be considerably enlarged and that the programme will be more important and more international in character. The discussion of fixed nitrogen is one of the topics which will receive close attention. The liquefaction of coal, which was one of the principal subjects of discussion at the first meeting, will again occupy a prominent place in the deliberations. Low-temperature distillation will be treated by representatives of at least a half-dozen countries. High-temperature distillation, power from coal, coal tars and oils, complete gasification of coal, origin of coal, coal washing, pulverised coal, catalysts, and the general aspects of the bituminous coal industry are other topics that will be considered.

Among Europeans who are expected to attend the Congress are Donat Agache, E. Audibert, Jean Bing, Emile Heurteau, Antonie Vonk, Paul Weiss, Henri Winckler, and Raymond Berr, France; Dr. Franz Fischer, Professor Fritz Hoffmann, Professor F. P. Kerschbaum, Dr. Carl Krauch, Dr. Friedrich Bergius, Rudolph Pawlikowski, Professor Ernest Terres, Professor Dr. Glinz, Dr. J. E. Noeggerath, Joseph Plassmann, Rudolph Battig, Dr. Karl Bunte, and Professor Fritz Frank, Germany; Lord Melchett, Dr. Cecil H. Lander, Harold Nielsen, Colonel Lindemann, Dr. R. Lessing, and Edgar C. Evans, England; Commendatore Alberto Edeardo Bianchi, and Engineer Guardabassi, Italy; Professor Dr. Granigg, Austria; A. France, Belgium; Professor P. E. Raaschou, Denmark; Professor H. Kling, Poland; Professors George L. Stadnikoff and L. K. Ramsin, Russia. Japan will be represented by Professors Yoskikiyo Oshima and Chozo Iwasaki. Delegates from Czecho-Slovakia, Canada, Norway, Spain, Chili, Roumania, Jugo-Slavia, and Bulgaria will also be present.

"The Economics of the Coal Industry" will be discussed by Lord Melchett. Dr. Friedrich Bergius, Professor Dr. Franz Fischer, Germany; Andre Kling and E. Audibert, France; Engineer Guardabassi, Italy, will deal with the subject of the liquefaction of coal.

"Low-temperature Distillation" will be treated by George E. K. Blythe, Dr. C. H. Lander, Harald Nielsen, Dr. E. W. Smith, England; Dr. A. Herz, Joseph Plassmann, Professor F. P. Kerschbaum, Germany; Henri Lafond, Professor Paul Lebeau, Antonie Vonk, A. Leante, France; Professor Dr. Granigg, Austria; Professor Yoskikiyo Oshima, Japan; Professor Samuel W. Parr, Professor Alfred H. White, and F. C. Greene, United States.

"High-temperature Distillation": Jean Bing, France; Professor Ernest Terres, Germany; Edgar C. Evans, England.

"Power from Coal:" Dr. J. E. Noeggerath, Germany; C. Simon, France; A. T. Stuart, Canada; W. B. Chapman and Professor A. G. Christie, United States.

"Coal Tars and Oils;" Henri Winckler, France; Dr. L. Edeleanu and Professor Dr. Fritz Frank, Germany; and Gustaf Egloff, United States.

"Gasification of Coal:" Dr. Karl Bunte and Dr. Alfred Pott, Germany; Paul Weiss, France.

"Origin of Coal:" Professor George L. Stadnikoff, Russia; Dr. Chozo Iwasaki, Japan; Dr. Reinhardt Thiessen and Professor E. C. Jeffrey, United States.

"Fixed Nitrogen:" a representative of L'Air Liquide Société, France; Rudolf Battig, Germany; Professor Harry A. Curtis, Louis C. Jones, and Charles J. Brand, United States.

"Coal Washing:" A. France, Belgium; Professor Dr. Glinz, Germany; Dr. R. Lessing, England; F. R. Wadleigh, Dr. F. W. Sperr, James B. Morrow, and Byron Bird, United States.

"Pulverised Coal:" Dr. I. P. Goosens, Rudolph Pawlikowski, and Dr. P. Rosin, Germany; C. J. Jefferson, United States.

"Catalysts:" Professor A. Mailhe, France; Professor Hugh S. Taylor, United States.

"Rubber from Coal:" Professor Fritz Hoffmann, Germany.

Addresses not yet classified under these headings will be given, it is expected, by F. S. Sinnatt, England; Raymond Berr, France; P. E. Raaschou, Denmark; John Hays Hammond, Howard N. Eavenson, E. E. Slosson, Dr. Arthur D. Little, A. C. Fieldner, and Dr. H. C. Parmelee, United States.

The members of the Advisory Board for the Congress are John Hays Hammond; E. M. Herr, President, Westinghouse Electric and Manufacturing Company; Samuel Insull; Frank B. Jewett, President of the Bell Laboratories, Inc.; Otto H. Kahn; George E. Learnard, President, International Combustion Engineering Corporation; A. W. Mellon, Secretary of the Treasury; Auguste G. Pratt, President, Babcock and Wilcox Company; H. B. Rust, President, Koppers Company; Charles M. Schwab, Chairman, Bethlehem Steel Corporation; W. C. Teagle, President, Standard Oil Company, New Jersey.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE RECOVERY OF WASTE HEAT.

SIR,—Your leading article on the above subject in last week's issue was opportune.

The necessity for a reduction in steel works costs has apparently led to the conclusion that the only field for economy is in the utilisation of waste heat, and invariably by waste heat is meant the available heat in the gases leaving open-hearth and other type furnaces.

Is it not necessary to adopt a more comprehensive meaning to the term "waste heat"?

Any heat which is capable of being converted into work, or usefully used as heat, but which is allowed to go to waste should fall within the term. Thus, the installation of what are generally known as waste heat boilers requires a full investigation of all the concomitant factors, whereas the investigations generally regarded as all sufficient are those which enable the designer to show that, from a given furnace, it is possible to produce x lb. of steam by the utilisation of waste gases from such furnace.

Generally the waste gas conditions of such furnaces allow an evaporation of approximately 2 lb. of water per pound of coal fired on the producers to be obtained, and this is a measure of the economy to be obtained as measured by reduced coal consumption. It is, of course, very appreciable, but I submit that in any steel works the problem of the utilisation of low-grade heat must be examined in relation to the whole works, and that the apparently obvious step of the installation of waste heat boilers may not be the complete economic solution.

In many cases where these units have been installed many thousands of pounds of exhaust steam pass every hour to atmosphere from rolling mill engines. In other works all gases leaving batteries of Lancashire boilers are abnormally high and in this constitute waste gases in the truest sense of the phrase.

In many cases it is possible so to arrange power conditions that a part of the load may be run non-condensing, utilising the exhaust steam for feed heating purposes with a resulting high efficiency of the unit so arranged.

Thus the full investigation of all the prevailing conditions seems to be necessary before the economics of any given case may be accurately known.

Engineering divorced from economics is no longer engineering.

Is the position in this and other fields of engineering not due to the fact that we are fast becoming highly specialised engineers, and that it is exceedingly difficult to find an engineer capable of surveying the whole field and analysing the effect of one proposition on the whole engineering structure, instead of confining such analysis to the effect on one phase only?

The design of the only possible type of waste heat boiler is a beautiful mathematical process involving the use of formulæ obtained by scientists over long periods, and those who have specialised are rather apt to confine their attention too closely to it, to the exclusion of other vitally important factors. The same thing occurs in other fields. I have before me the report of the Engineering Conference arranged by the Institution of Civil Engineers in 1928. Mr. Patchell introduced the subject of "Present Trend of Boiler Practice." His remarks and the resulting discussion showed conclusively that contributors had in mind solely the trend of boiler practice for power stations, and it would have been better to have so described the discussion.

In that discussion Mr. Thomas Sugden presumed that Mr. Patchell referred to power station boilers, and reminded

the Conference that there are other uses to which steam boilers are put, and these remarks appeared to be the only sign that the meeting appreciated the widely divergent conditions under which boilers operated in different fields. This divergence was made very clear by Mr. Patchell when he stated that the type of boiler now being used is, comparatively speaking, a flash boiler, and showed that if the feed be stopped on a unit of 100,000 lb. per hour a dangerous condition would arise in two or three minutes.

The interesting problem of steam-driven rolling mills and the phenomenon of accumulator effect in large boilers at once occurs to me, showing that the present trend of boiler design for power stations must be reconsidered in the light of steel works conditions. I have before me an actual chart taken from a battery of boilers supplying such engines, and although the rated capacity of the battery of boilers is about 60,000 lb. of steam per hour, they actually supply, owing to pressure drop, almost twice that amount for very short intervals. It follows that if a boiler such as is stated to be typical of present-day trend were installed on a steam-driven rolling mill load, it would have to be of such a capacity that it could deliver the steam to meet the peaks without the aid of accumulator effect. The economics would be an interesting problem and would involve a comparison of the capital costs of a highly efficient water-tube unit with no accumulator capacity, with less efficient units of much lower capacity, but built to handle the peaks by reason of their water content. Probably some combination of the type referred to by Mr. Patchell with carefully chosen units of the shell type will be the ultimate arrangements for steel works where the steam-driven mills are retained.

It is interesting to note that so far as boiler design for the heavy industries is concerned much more valuable information was forthcoming from the discussion of the subject "High-pressure Superheated Steam for Marine Propulsion." In that discussion Mr. John Johnson described the installation of medium-pressure single boilers to work in conjunction with high-pressure water-tube boilers, and herein, in my opinion, lies the path for the design of more efficient but equally reliable units for steel works and similar industries. My excuse for apparently wandering so far from my subject of waste heat is that many of the points arising in that problem appear to be due to the naturally limited vision of the specialist, and it appeared expedient to refer to the problem of boiler design as another case in which the specialist's view is far too narrow.

Steam accumulation is another phase of engineering which will undoubtedly be developed extensively in the near future, but here again it is not safe to jump to conclusions as to possible results without a full examination of all the possible alternatives.

There are cases, of course, in which the system could be economically installed, but again there are cases in which the conditions would be more economically met by a combination of back-pressure or pass-out units, possibly combined with the two types of boilers referred to above. Of course, no generalisation is possible.

I plead merely for a more comprehensive view by the specialist engineer, or, at any rate, that his ideas may be tempered by collaboration with those who are not handicapped by being bound up too completely with one particular phase of engineering, and a recognition of the fact that the only solution of an engineering problem is the economic one.

G. E. Hider,
Swansea, August 27th. A.M. Inst. C.E., M.I. Mech. E.

Sir,—Your editorial of August 24th is so obviously provocative that we have no hesitation in writing you thereon.

It is unfortunate that at this holiday season few people may read your remarks or our comments thereon!

"The case for the waste heat boiler" *is* "unanswerable"—not "seems" as you suggest.

Although the iron and steel trade of this country is not very busy at present, yet about 8,000,000 tons of open-hearth steel are being made per annum, and in doing this the equivalent of at least 1,000,000 tons of coal are lost up the chimneys as waste heat. Of this, 50 per cent. could be recovered by waste heat boilers; 500,000 tons of coal are worth at least £400,000. Thus, there is quite "enough heat going to waste to warrant the expense."

The "many instances" of "undoubted economy" you admit, and with which we are acquainted, show that on the conservative estimates made by our customers the return on the capital invested is at least 50 per cent. per annum, and yet you go out of your way to "praise with faint damns!"

In addition to the direct advantage of fuel saved—and surely this is of national importance—there are many indirect advantages resulting from the adoption of waste heat boilers—output improved, handling of boiler ashes saved, &c.

We have not found any difficulty raised by our customers as to how to make use of the free steam provided by our waste heat boilers. On the contrary, the economy realised enabled one large steel maker to carry on all through the disastrous coal strike of 1926.

Must all these benefits await better refractories or metallic recuperators?

Instead of the tendency being to electrify mill drives, the use of waste heat boilers with steam engine drive is now preferred, and, speaking of the majority of British plants it would seem that this is a very logical and reasonable course. The quantity of steam used for the generation of electricity for electric drives may be less than that required for a corresponding mill engine, but this steam represents so much coal burnt in the power station boilers, while the steam used by the mill engine can be obtained from waste heat boilers at no cost for fuel.

You mention leaving gas temperatures of 1600 deg. Fah. as an upper limit. This is an absurdly extravagant figure to have in mind, and would mean sending up the chimney about 50 per cent. of the total heat value of the fuel, whereas 30 per cent. is more usual. We have waste heat boilers giving satisfactory financial results on waste gas below the 900 deg. Fah. you suggest as the lower limit.

Mr. Stevens' experience must have been unfortunate if he wishes "to do without waste heat boilers at all" (*sic*), but perhaps this is because he had not available the help of British boilermakers. It would have been as well if the writer of your article had awaited the publication of two papers on the subject that should shortly appear in the *Journal* of the Institution of Mechanical Engineers. Or is it a case of over-anxious anticipation?

Your article is typical of much of the criticism in this country. As soon as a fellow-countryman shows where an improvement can be effected, he and those who would support him are discouraged by members of his own fraternity.

In the interests of engineering you ought to be urging steel makers to spend money now on the best equipment, so as to be ready for the trade recovery that is bound to come when the world gets tired of being misled by politicians and the like.

Joseph Adamson and Co.
Hyde, Cheshire, August 27th.

Sir,—I have read with great interest the leading article in your issue of the 24th inst., dealing with the above subject, and also referring to Mr. R. H. Stevens' recent paper before the American Iron and Steel Institute.

The statement that the furnace unit itself should be as efficient as possible is, of course, fundamentally sound—*i.e.*, waste heat boilers should not be used as a cloak for the deficiencies of the prime process. What, however, is usually designated "waste" heat is, in a well-operated plant, "surplus" heat, which, owing to the inherent characteristics of the primary function, must of necessity be rejected, as it is incapable of direct recovery and return to the furnace itself. The determining factor in this consideration is the proportion of ingoing air of combustion to outgoing gases, and with producer or equivalent gas firing combined with the furnace temperatures required for modern practice it has been proved conclusively that the maximum regenerator and/or recuperative efficiency is represented by approximately 50 per cent. of the total outgoing heat units.

In other words, with a properly designed furnace-cum-regenerator system fired in the usual manner the gases leaving the regenerator will have a temperature which is about half that appearing in the furnace unless diluted and cooled with infiltrating air which has diffused into the system. In practice it is practically impossible to prevent ingress of air; hence it will be appreciated that statements based solely on exit gas temperatures are exceedingly misleading, and unless studied in conjunction with the air content at successive stages are useless.

It cannot be too strongly emphasised that the only criterion of furnace efficiency is the amount of heat expended per unit of finished product, and low exit gas temperatures without consideration of other factors give no measure of furnace efficiency. Furthermore, adding regenerator or recuperator surface cannot increase heat re-absorption beyond the predetermined limit, and any additional temperature reduction by this added surface is simply due to the increased facilities for infiltrating air and to a less extent the increased radiation losses.

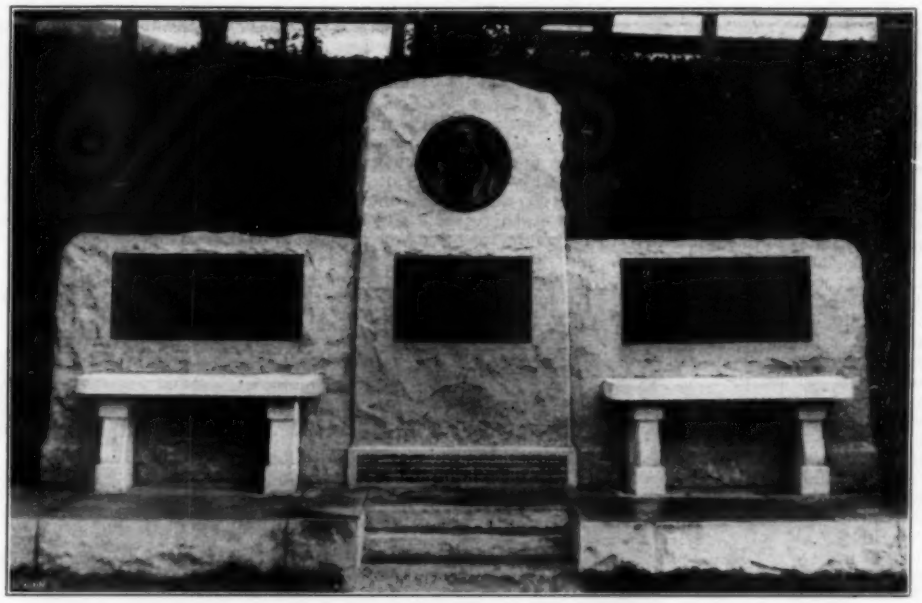
I can speak from a considerable experience in testing furnaces, and can point out that the most efficient furnaces are those where the heat leaves the regenerative system at a temperature round about the true theoretical leaving temperature—*i.e.*, about half the furnace temperature.

I have, I believe, read most of the American and continental literature dealing with this subject, and in all cases this aspect of the matter appears to have been completely disregarded.

May I also join issue with you over another matter? I can assure you that there is no difficulty whatsoever in linking up a system of waste heat boilers so that the steam can be effectively used in the central works power station, provided proper care is taken with the lay-out of mains and moderate superheat used. Furthermore, British practice is to use steam drives for mills, owing to the economic advantages of the cheap steam available from the waste heat recovery system, and this all assists the general lay-out.

W. Gregson,
Chief Engineer and General Manager,
Spencer-Bonecourt, Ltd.
Westminster, S.W. 1, August 26th.

TELFORD MEMORIAL AT WESTERKIRK



Thomas Telford Memorial.

As we announced at the time, a memorial to Thomas Telford, which had been erected at Westerkirk, near Langholm, in Dumfriesshire—his birthplace—was unveiled by the Duke of Buccleugh on August 3rd. The memorial, a photograph of which is reproduced above, is of local granite. It takes the form of seats arranged to command a view of the confluence of the Meggat and the Esk, and of the valley in which Telford was born and spent his early boyhood. At the top of a central column is a bronze medallion in bas-relief of the great engineer. Below it is a rectangular bronze tablet bearing the inscription:—

"Thomas Telford, F.R.S., born 9th Augt., 1757. President of the Institution of Civil Engineers from 21st March, 1820, to the time of his death 2nd Sept., 1834."

At the foot of the column, but cut in the stone itself and not on a bronze, are the following words:—

"Erected in the Centenary Year (1928) of its Grant of a Royal Charter by the Institution of Civil Engineers, in conjunction with the Eskdale and Liddesdale Archæological Society."

Midway between bronze and inscription there is cut in the face of the stone a star made by the intersection of three lines, which was the mark Telford used to indicate his own workmanship when he was operating as a mason.

The bronze panel on the left wing—as seen from the front—carries the following inscription:—

"This seat was erected in 1928 to perpetuate the memory of Thomas Telford, son of the 'Unblameable Shepherd,' and to record his fame as an Engineer and his untiring benevolence. Apprenticed to a stonemason in Langholm. His creative genius gave to the nation many works of inestimable benefit. He was the first President of the Institution of Civil Engineers."

Finally, on the right bronze panel there is the following verse:—

"There, 'mongst those rocks I'll form a rural seat,
And plant some ivy with its moss compleat;
I'll benches form of fragments from the stone,
Which, nicely pois'd was by our hands o'erthrown."

This verse, it may be explained, was written by Telford himself, and is taken from one of his earlier poems.

The Steel Company of Canada proposes to spend between six and seven million dollars on the extension of its plant at Hamilton, Ontario.

The Government Airship R 101.

ON Thursday of last week we were, by the courtesy of the Air Ministry, afforded an opportunity of making a detailed inspection of the rigid airship R 101, commonly known as the Government airship, now in course of construction at the Royal Airship Works, Cardington, near Bedford. This airship is being built under an airship development programme formulated during Mr. Ramsay Macdonald's tenure of office. That programme covered the carrying out of a considerable amount of experimental work, including flights by the now dismantled war-time airship R 33, the development of a ground organisation to enable experimental flights to be conducted on the England-Egypt-India route, and the construction of two airships, each of 5,000,000 cubic feet capacity. The general requirements laid down for the airships were that they were to be capable of flying at a minimum speed of 70 m.p.h. at a height of 5000ft., to have a cruising speed of 63 m.p.h., and, in still air, with an ordinary commercial load to have a range, at the cruising speed, of about 4000 miles without re-fuelling. The second airship, the R 100, is being built for the Air Ministry by the Airship Guarantee Company at Howden, Yorks. The designers of the two vessels have, subject to the general conditions just referred to, had a free hand given them, and, as a consequence, the two vessels present many important points of difference. They are, however, alike in so far that both are being fitted with living, dining and sleeping accommodation for one hundred passengers—eventually, if not at first—and for a crew of about fifty.

Before describing what we saw at Cardington last week we may briefly summarise the present position of the programme as regards the ground organisation work. That work has covered the enlargement of the existing airship shed at Cardington and the erection of a mooring tower about a mile away from the shed*, the transference of an existing airship shed from Pulham to Cardington and its enlargement, the erection of a shed† and mooring tower at Karachi, India, and the provision of a mooring tower and hydrogen plant at Ismailia, Egypt. The Cardington and Egyptian bases are now completed and the Indian base is expected to be finished early in 1929. The ground organisation also includes the establishment of a meteorological service covering the England-India route with centres at Cardington, Malta, Ismailia, Baghdad and Karachi. During our visit to Cardington last week we inspected the meteorological forecasting station which has been erected there, and were much impressed with the thoroughness and high scientific standing of the weather service which is being prepared for the experimental voyages of the two airships. Particular attention is being given to the study of thunderstorms over the route, not so much because of the danger of the airships being struck by lightning, but because of the very rapid vertical currents which occur during such storms. The loss of the United States airship "Shenandoah," it may be recalled, was directly attributed to the rapidity with which she rose and fell when caught in the vertical currents of a violent thunderstorm.‡

Outside this country, Egypt and India, the Dominion Governments are showing considerable interest in the development of an Empire airship service. In Canada an airship and aeroplane base has been established at St. Hubert, Montreal. An airship tower is being erected there. The tower structure is being manufactured in Canada. The tower head machinery equipment, made at Lincoln, England, was shipped to Canada about six weeks ago. It resembles the Cardington equipment, but is operated by compressed air instead of by electricity. In South Africa a site for a mooring tower base has been selected at Groutville, about 38 miles north of Durban. It is expected that the Air Ministry will be in a position in the near future to call for tenders for the mooring tower and its equipment on behalf of the South African Government. The Commonwealth Government of Australia has approved of the purchase of a site for an airship base near Perth, W.A., and the New Zealand Government has, it is understood, also earmarked a suitable site.

On entering the Cardington shed last week we found the airship R 101 so far as its framework is concerned in an advanced state of construction. When finished, the vessel will have a length of 724ft. 3in., a maximum diameter of 131ft. 8in., and a gross height, over the control car, of about 140ft. The five million cubic feet of hydrogen gas carried in her sixteen gas bags will give a total lift of something over 150 tons. A useful illustration of the step forward in dimensions which she marks is conveyed by comparing her cross section with that of the R 33. If the section of the old airship be taken as being represented by a sixpenny piece, that of the new vessel would be represented by a half-crown. At present the R 101 is the largest airship in existence or under construction in the world, although she is, of course, very closely rivalled by the R 100. How long this distinction will attach to her is uncertain, for the United States Government is now calling for tenders for the construction of two 6¼ million cubic foot airships.

The general framework of the R 101 will consist of sixteen vertical polygonal frames—numbered 0 to 15 from the nose to the tail end—each frame having fifteen sides and being joined to its neighbours on either side by fifteen longitudinal girders which run continuously from end to end of the structure. Beyond frame No. 0 there will be a nose cap containing a spindle for the mooring rope, and beyond frame No. 15 there will be a light tailpiece about 60ft. in length. Two egg-shaped cars, each containing a 650 horse-power Beardmore heavy oil engine, will be attached to frame No. 4. Two similar power units will be attached to frame No. 9, and one other will be attached to frame No. 11 on the centre line. A control car for the helmsmen and navigating officer will be slung beneath frame No. 6—it can just be discerned in position in the general view of the structure reproduced herewith. With the exception of the five engine cars and the control car, all the accommodation will be within the hull structure. That accommodation will be concentrated on two decks lying between frames 6 and 8. The lower deck will have an area of 1730 square feet and will carry the captain's control room—with the projecting control car directly beneath it—a wireless cabin, an electrical kitchen, a smoking room, lavatories and crew's quarters. The upper deck will have an area of 5550 square feet and will carry a dining room for fifty persons, a number of two-berth sleeping cabins, and a large lounge with promenades on each side, from which the passengers will be able to obtain a good view through windows in the outer covering.

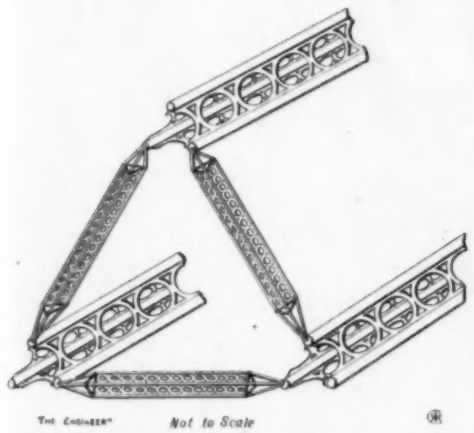
AIRSHIP R 101—STATE OF CONSTRUCTION ON AUGUST 23RD, 1928

It is, we find, quite a mistake to describe the Government airship as having a framework of steel. The Airship Guarantee Company's vessel is, we believe, being constructed with a framework entirely of duralumin. In the case of the Cardington airship there is about as much duralumin as steel worked into the structure. For example, the triangular sectioned main longitudinal girders are composed of three tubular steel booms held apart by tubular struts of duralumin. Again, the main transverse frames are composed of members, each of which is built up of three tubular booms of steel united by circularly pierced webbing of sheet duralumin. The whole of the control car, the sheathing of the engine cars and much of the subsidiary girder work is made of duralumin. The fabrication of the steel components was entrusted to Boulton and Paul, Ltd., of Norwich, who have, for a number of years, specialised in the production of rolled and drawn steel work for aeronautical use. The bulk of the duralumin work was fabricated at the factory itself. While on the subject of the materials of which the airship is being built we may record that in the passengers' quarters the woodwork fairing, panelling, &c., is, or will be, made from *lata balsa* wood, an exceptionally light wood obtained from the swampy regions of Brazil, possessing half the strength of spruce and weighing only 6 lb. per cubic foot.

In the accompanying sketch we have endeavoured to represent the construction of one of the main transverse frames. The design is believed to be quite novel and on it much depends. In section, the frame is an equilateral triangle with the apex pointing towards the centre of the gas bag structure and the base lying parallel with the longitudinal direction of the outer covering. Put otherwise, each complete main frame consists of an inner ring and two outer rings, the three rings being spaced equilaterally by means of groups of three struts. Each ring and each strut is composed of three steel tubes arranged equilaterally and united by duralumin webbing. One outstanding feature of this design is that the main frames are sufficiently stiff without the use of the transverse wire bracing which has hitherto been employed in airship construction. As a test one of the frames was suspended from a single point at the top and a weight of 6 tons was loaded on to it at the bottom. The vertical diameter of 130ft. was found to increase under the load by only 4in.—that is to say, the diametral extension was about one-quarter of

* See THE ENGINEER for March 4th, 11th, and 18th, 1927.
† See THE ENGINEER for December 24th, 1926.
‡ See THE ENGINEER for October 8th, 1926. Report of Lieut.-Com. Rosendahl, U.S.N., senior surviving officer.

1 per cent. The design of the main frames is also such as to permit very rapid erection and to eliminate a large amount of assembly work at great heights above the floor. The frames are assembled lying on their sides on the floor of the shed, and when completed are lifted vertically into position. The lifting operation occupies only about twenty minutes. While the frames are still on the ground the fuel tanks, piping, ladders, &c., are fitted in position. After they have been erected vertically the work required to be done in the air consists only of joining up the longitudinals



SECTION OF MAIN TRANSVERSE FRAME

of adjacent frames and coupling together the fuel, oil and other pipes. The rapidity with which this system permits the erection work to proceed can be gauged from two of the accompanying engravings representing the interior of the shed on May 31st and June 27th, 1928, respectively. By July 15th two more frames had been erected and a gas bag placed in position and inflated for test. The condition of the vessel on the date of our visit, August 23rd, is represented in a third engraving.

The gas bags are composed of goldbeaters' skin derived from the stomachs of over a million head of cattle. It is worthy of note that, unlike the R 100, the Government airship will be equipped with gas bags entirely of British manufacture. The bags do not touch the frame structure at any point. They are tied by lift wires to every joint of the main frames and girders up to the level of the central plane. A simple picture of the manner in which the lift of the gas bags is conveyed to the structural parts of the vessel can be obtained by likening the structural weight to the weight of a parachutist whose parachute is held up by means of a spherical balloon fitting closely within it.

The absence of cross bracing wires in the main frames relieves the gas bags of endwise restraint, eliminates the risk of the bags being pinched between the wires, and overcomes certain difficulties previously met with in the matter of end pressure. Extra pressure in any one of the bags will cause that bag to press outwards against its neighbour on each side and consequently will result in the extra pressure being distributed throughout all the bags. The bags are of such form that any of them can extend about 25 per cent. into the two adjoining bays when these two bays are not occupied by their own bags or if the bags in them are not inflated. The design is such that the ship will fly and remain navigable with any two of its bags out of use, even with two adjacent bags deflated.

The bags are fitted with a new form of gas valve designed to serve both as a manœuvring valve and as an automatic valve. From his position in the control car the captain can, if he wishes, discharge gas through the valves even if the bags are not full. At the same time the valves will discharge gas automatically if the relative pressure exceeds a given value. The valves are designed to deal with the conditions of a rise at a rate of about 4000ft. per minute, a rapidity greater than that provided for in any previous airship.

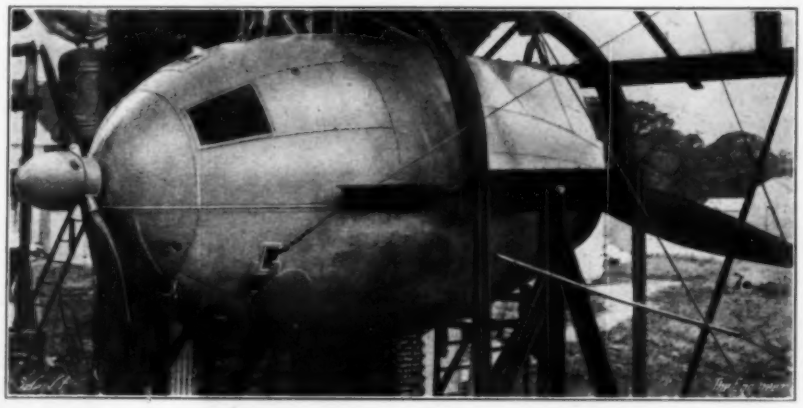
The outer covering of earlier airships has been doped after it was placed in position and tightened by lacing. In the R 101 the outer covering will be a predoped fabric and will be tightened and maintained taut by a mechanical method. Midway between each pair of longitudinal girders small duralumin "reefing booms" are fitted, which can be pushed outwards to tighten the fabric covering. The effect of these booms is to convert the fifteen-sided polygon of the airship section into a polygon of thirty sides. The necessity for these reefing booms will be apparent when it is learnt that the dynamic lift on the hull of the airship at full speed amount will to about 20 tons.

A corridor runs along the interior of the frame structure near its lowest level and will serve to provide communication from the passenger quarters to a closed-in drop gangway at frame No. 1, near the nose of the ship, whereby the passengers and crew will enter the vessel from the mooring tower. At frame No. 2 there will be a platform from which the trail rope and handling lines will be lowered. Between frame No. 0 and the nose cap there will be a small cabin containing the winches for the mooring rope and also the electric, water, gas, air and fuel connections for use when the ship is riding at the mooring tower.

At the tail end the fins and flaps will be carried by frames Nos. 13, 14 and 15. Each of the flaps measures 44ft., and in order to assist the coxswain to operate these huge surfaces servo-motor equipment embodying Vickers-Janney variable-speed gearing actuated by electric motors will be provided. This equipment will be housed in the lower fin. The ship can be operated from this position in the event of a failure of the cables passing through the hull to the control car. Each of the four fins, including its flap, will have an area of about 2200 square feet.

At frame No. 5 a ladder and stairway will be provided round the inside of the frame to give access to a cockpit at the top of the ship. At several of the other frames ladders and stairways carried up to the mid-height will enable the crew to proceed along the longitudinal girders between the gas bags and the outer cover for the purpose of inspecting the gas valves.

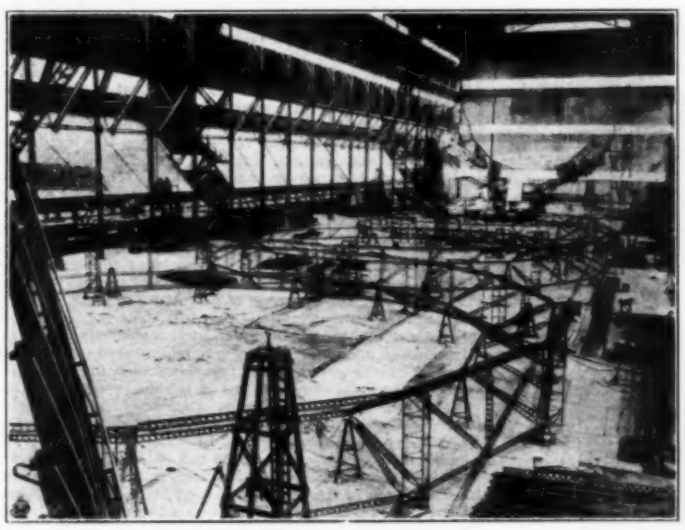
Tankage is provided for 29 tons of heavy fuel oil in a number of large tanks each holding 224 gallons—1870 lb.—and in a number of small tanks of half that capacity. In addition, on the passenger decks there are a number of tanks which are intended to be used for compensating ballast when the full number of passengers is not being carried. These tanks can also be used as additional fuel tanks on long demonstration flights without passengers. When they are so used the total fuel storage capacity of the airship will amount to 37 tons. Certain of the fuel tanks are fitted with special discs and cutters working on a principle similar to that employed in cigarette tins, whereby their contents may be rapidly discharged in an emergency. The fuel from any of the storage tanks can be run down into special pressure tanks, whence it can be blown by compressed air to any of the engine cars.



ENGINE CAR ON TEST GANTRY

Water ballast will be carried in emergency bags holding a total of 7 tons and in tanks holding 8 tons. The water in the tanks will be capable of being transferred to any part of the ship by means of compressed air. The water tanks, if all the ballast is not required, can be used to hold fuel oil, in which case the total fuel capacity will be 45 tons.

The engines, as we have said, are carried in five outboard cars. Each car is self-contained and can be replaced by a spare unit quite readily even when the ship is riding at the mooring tower. It is intended, in fact, that the power units shall be replacable almost as readily as a fresh locomotive is attached to a train. Two views of an engine unit are reproduced herewith. The engine is an eight-cylinder Beardmore heavy oil engine using a special fuel having a flash point of 210 deg. Fah. and flowing satisfactorily at temperatures down to 0 deg. Fah. Each engine drives a two-bladed hollow steel pusher screw made by Metal Airscrews, Ltd. In the nose of the car there is a small auxiliary engine by which the main engine can be started through a Bendix gear. This engine in two of the cars also drives an air compressor for supplying the air required for transferring the fuel and water ballast from point to point on the ship. In the three other cars the auxiliary engine drives an electric generator. When the ship is proceeding at speeds in excess of 40 m.p.h. these generators can be uncoupled from the auxiliary engines and coupled up to variable-pitch windmills at the nose end of the cars. These windmills

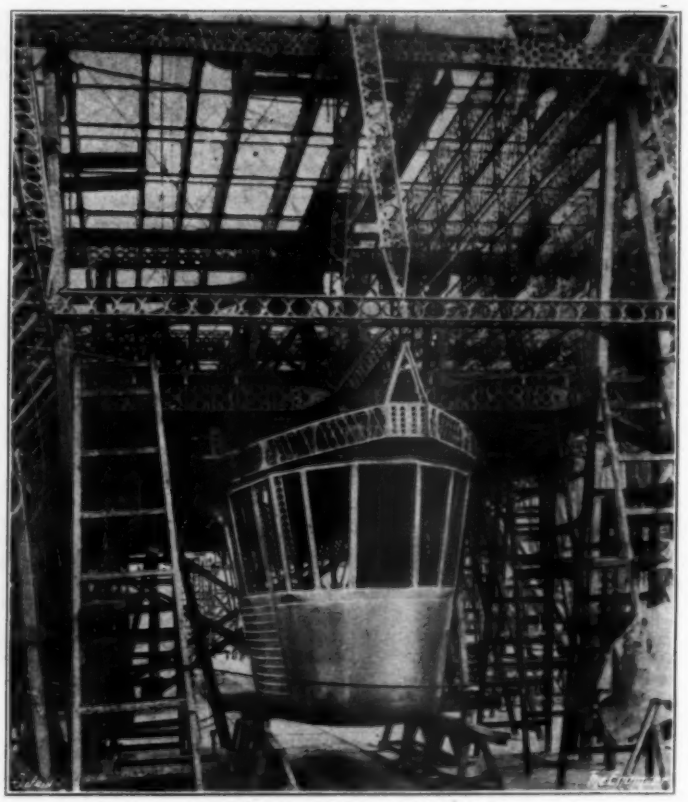


ASSEMBLING MAIN FRAMES—MAY 31ST, 1928

PASSENGER DECK FRAMEWORK

THE BRITISH RIGID AIRSHIP R101

SIX MAIN FRAMES ERECTED—JUNE 27TH, 1928



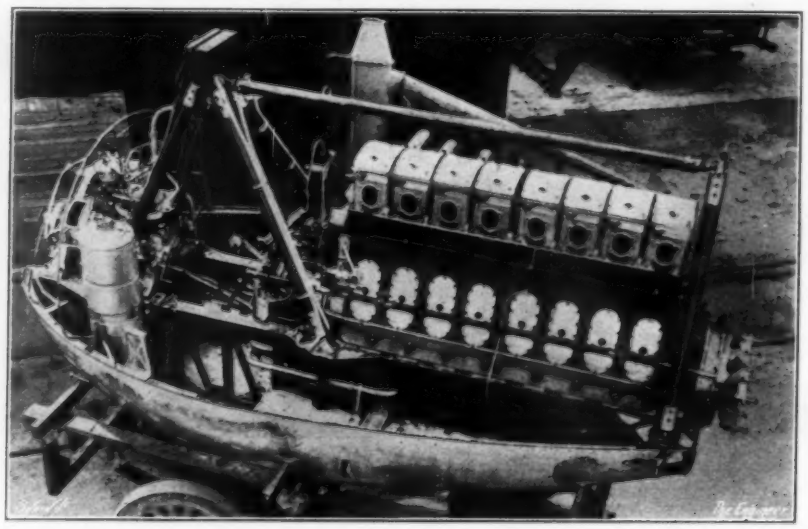
CONTROL CAR

act automatically to keep the speed of rotation constant.

The two-bladed main propellers are provided with a hand-controlled variable-pitch arrangement. The variation of the pitch permits an ahead or an astern or a neutral thrust to be given without stopping the engine or reversing its direction of rotation. At full speed the centrifugal force on each of the propeller blades amounts to about 40 tons. The frictional resistance at the collar of the blade accompanying this great force is relied upon to lock the blade in any set position. To vary the pitch the engine speed is reduced to a low value, at which the centrifugal force is about 1 ton. If any one of the engines is not required during flight the blades of its propeller can be put into the fore-and-aft position in order to reduce the drag. Should it be required to restart the engine while the ship is in flight the decompressing valve can be opened and the blades operated so as slowly to increase their pitch. The rush of air past the car can in this way be made to start the engine without calling upon the auxiliary engine, which may be otherwise employed at the time.

The engines are water cooled by means of condenser-radiators. Steam only passes to the radiators. As a result the radiators can be placed at any convenient distance from the engine cars without incurring the prohibitive weight which would be involved if the connecting pipes were filled with water. From the engine cars adjacent to the passengers' quarters the steam from the engine jackets can be led to an internal radiator for warming the living spaces. When such warming is not required the radiator can be lowered so as to project into the air passing below the outer cover.

As there has been a certain amount of discussion concerning the use of heavy-oil engines in airships, it may here be noted that their use is claimed to increase the trustworthiness of the power equipment by eliminating carburetters and magnetoes, to give increased safety by reason of the higher flash point of the fuel used as compared with petrol and, perhaps the most important advantage of all, to eliminate the fumes which in the past have proved a source of much unpleasantness and danger in petrol-driven airships. It may be remarked that the fumes from petrol in an airship moored at a tower when there is little or no current of air through her internal spaces have been known seriously to affect those on board her. For an airship which is to operate in hot tropical climates it is therefore particularly desirable that there should be no petrol on board from which fumes could arise. The fumes are not only toxic, but, of course, highly dangerous from the point of view of fire. We have been told on good authority that several enemy airships during the war were destroyed by incendiary bullets penetrating to the petrol-laden atmosphere of the internal spaces rather than by piercing the hydrogen gas bags.



650 H.P. ENGINE AND AUXILIARY ENGINE

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SIXTY YEARS AGO.

IN our issue of August 28th, 1868, we dealt in a leading article with the Abergele railway accident, which had occurred on the Thursday of the previous week, August 20th. The accident, "a calamity absolutely without precise parallel in the history of the railway system," occurred to the Irish mail train which left Euston at 7.15 a.m. At about 1 p.m. the train reached and passed Abergele, a little Welsh town near the sea coast, and was proceeding at about 28 miles an hour up an incline of 1 in 90 on a sharp curve. While ascending this incline the driver saw some vehicles detached from a preceding goods train descending the line towards him. They were close upon him before he saw them, and shutting off steam he jumped from his engine. A collision, which was not particularly severe, immediately took place. The tender, we recorded, jumped clean over the engine, but none of the carriages left the rails. Had the accident ended there, no lives probably would have been lost. The runaway trucks, however, contained barrels of petroleum or shale oil The casks were burst by the shock and their contents were set alight by the engine fire. Instantaneously, "the air around the doomed carriages was transmuted into a dense cloud of lurid tawny flame," within which life could not exist. The flames were fanned by the sea breeze and swept the carriages from side to side. In a brief instant, thirty-three people on the train were burned to death. The fiery river as it flowed along became soaked up by the ballast, and as a result the rear end of the train, including the Post Office vans, escaped undamaged. Beyond recording the facts of the disaster we said little about it. Comment was passed on the allegation that the detached trucks had been started on their journey down the incline by an impact, received during shunting operations, which had caused the brake to spring off. The goods train should have reached Conway half an hour before the mail train was due, and should there have been shunted to allow the mail to pass. It was apparently late on the morning of the disaster, and, in addition, had stopped at the Llandulas quarries a short distance beyond Abergele to pick up some trucks. During the breaking up and re-assembling of the train the petroleum trucks were left standing on the incline with their brakes alone holding them against running away. Apparently, when they were about to be recoupled to the train their brakes shook off, and they started their fatal descent. There are several features of the accident and several obvious comments, which we of this generation might notice or make. Sixty years ago much that was "little short of nonsense" was written concerning it by correspondents in the daily Press. Even we did not escape the expression of fatuous opinion in our correspondence columns. One writer declared that the accident was the result of the unfortunate mistake made by engineers who constructed lines otherwise than on a dead level. Another correspondent used the accident as a medium for advancing his favourite theory that passenger trains and goods trains should everywhere have separate lines provided for them.

Railway Matters.

IN the collision at Ancoats, Manchester, on July 29th, the guard who had just taken charge of the excursion train to work it over the London, Midland and Scottish system was killed. Now, the London and North-Eastern Railway man who had brought the train from Hull and who was being relieved, has died from injuries he received.

A RAINSTORM on the afternoon of Sunday, August 12th, swept away a bridge of 50ft. span and two smaller bridges on the main line of the Highland section of the London, Midland and Scottish Railway between Brora and Loth. Passengers were conveyed by road over a circuitous route between Brora and Helmsdale. Fortunately the results were not as bad as when Baddengorm Burn swept away the bridge at Carr Bridge on June 18th, 1914, and carried a passenger train with it, causing five passengers to be drowned.

OUR annual article on Railways for the last three years has had a reference to changes being made at Cardiff, Queen-street, Station. The work was necessary to allow passengers for the docks from the Rhymney and the Cardiff Railways to enter that station, instead of having to alight at Cardiff Parade Station, and proceed then by the Taff Vale trains. It would also permit of a new through route for mineral traffic between the former lines and Cardiff Docks. The alterations have now been completed and, incidentally, two new signal-boxes have displaced five previously necessary.

ACCORDING to the Railway Returns for 1927, out of the 23,987 locomotives owned by all the standard gauge railways, the maximum number in use on any one day was 17,973. The average daily number available for use on week-days was 18,316, or 76·36 per cent. of the total; the number actually in use was 17,049, or 93·08 per cent. of those available for use and 71·08 per cent. of the total stock. That means that nearly 30 per cent. of the engines are, on an average, daily under repair, awaiting repair, or out of traffic for shed purposes. The average time an engine is in work on week-days is 12·47 hours, and the average distance run on week-days is 100·63 miles.

A VERY generous appreciation of the safety of travel by rail was implied in a leading article entitled "Dangers of the Roads," in *The Times* of August 15th. The second paragraph of the article began, "In the same way the contrast between the roads and the railways in the matter of safety is so much of a commonplace that it hardly attracts any attention," and after a reference to the small number of railway accidents, it proceeded to observe, "Yet when a train accident does cause loss of life, even though the victims may be fewer than those killed on the roads in a single week-end, the public are apt to look upon it as a national disaster, and, in any case, it is at once made the subject of a searching official investigation."

IT is a ticklish job to take a heavy train into a terminal station, especially when, owing to the length of the train, it is necessary to run up to the buffer stops. Particularly is that the case with Euston, as it is approached by a long length of falling gradient of from 1 in 70 to 1 in 112. The entrance into Nos. 1 and 2 platform roads is made yet more difficult by the curvature of the line, which gives a driver a rather short view of the buffer stops. There was a buffer stop collision in No. 2 road on the afternoon of Monday, August 27th, in which the 9.45 a.m. from Manchester was concerned, and in recording that fact we would have the conditions named above borne in mind. It should be added that because of the difficulties of approach there is a speed limit of 10 m.p.h. laid down for trains entering the station.

ACCORDING to the Board of Trade returns the value of the railway material exported during the first half of the present year was as follows, the corresponding figures for 1927 and 1926 are added in brackets:—Locomotives, £2,051,244 (£843,804, £1,990,812); rails, £1,867,502 (£1,193,207, £1,143,706); carriages, £1,499,495 (£1,712,491, £1,125,050); wagons, £1,775,886 (£1,091,633, £1,743,908); wheels and axles, £465,105 (£302,243, £283,028); tires and axles, £301,591 (£266,173, £152,886); chairs and metal sleepers, £547,010 (£534,663, £561,625); miscellaneous permanent way, £758,519 (£759,321, £577,101); total permanent way, £4,013,311 (£3,206,976, £2,841,672). The weight of the rails exported was 214,843 tons (144,494 tons, 146,797 tons), and of the chairs and metal sleepers, 55,256 tons (53,642 tons, 57,931 tons). During the month of June alone the value of the locomotives sent overseas was £436,697, which included:—The Argentine, £263,157; India, £59,987; Ceylon, £41,055; Straits Settlements, £25,755; Australia, £10,580. For the same month the rails exported were of the value of £222,170, and included:—The Argentine, £84,489; Portuguese East Africa, £33,820; India, £25,584; British West Africa, £11,941; New Zealand, £11,779; Ceylon, £8576; South Africa, £5567; and Straits Settlements, £1950.

THE annual returns of railway accidents is always supplemented by an annual report which summarises and comments upon the figures in the returns and, in particular, gives information as to the accidents inquired into during the year. The first such document was by Captain Tyler, after the Act of 1871, and dealt with the figures for 1870. Until the establishment of the Ministry of Transport the quarterly accident returns, the yearly returns and the annual report were presented to Parliament and published as Command Papers. Now only the latter is so treated; the remainder are merely Stationery Office publications—one result of that is that only the report bears a distinguishing number, and the remainder have to be given their titles. These observations are prompted by the fact that on August 25th Colonel Sir John Pringle's report, Cmd. 3181, on the accidents during 1927 was issued. We have not space to review the document; suffice to say that it gives the number of persons killed and injured, the average according to numbers of passenger-journeys and to train mileage; the inquiries held and features of the more serious accidents; the avoidable methods of prevention; level crossing accidents and accidents to railway servants. Generally, the present document deserves to be studied by all railway officers and those who are interested in railways, and is well worth the sixpence it costs.

Notes and Memoranda.

IT has been found in Pittsburg that an extensive business can be built up in the sale of ready-mixed concrete, which is delivered by motor wagons from a central mixing plant.

THE boundary lines between Canada and the United States and between Canada and Alaska have a total length of 5526 miles, and they have been marked by 5460 monuments. The longest straight course is 647 miles.

THE helium production plant of the United States Government near Amarillo, Texas, will be served by a natural gas bore-hole, which has a flow of 7,100,000 cubic feet a day and a rock pressure of 725 lb. per square inch.

IT appears from a report of the Victorian State Electricity Commission that while the tender of the English Electric Company for a turbo-generator plant amounts to £36,784, excluding duties, the contract will involve the expenditure of £30,814 additional in Australia. The duty amounts to £14,816.

IT has been found on one of the American railways, where bad water has to be used for the locomotives, that corrosion can be stopped by using a shunt off the electric lighting set to provide a small current passing between anodes suspended in the boiler and the shell, and by feeding the boiler with from 2 lb. to 4 lb. of an arsenic salt per month.

A NEW form of tower for mounting the instruments used in geodetic surveying has been developed in the United States. It is of steel in two parts. One tower 75ft. high carries the theodolite and another, surrounding it, is for the observer. Each twin tower weighs about 4000 lb. The towers can be easily and quickly dismantled for moving into new positions.

RECONSTRUCTION of the earthquake-damaged cities of Tokyo and Yokohama has proceeded with remarkable rapidity since the catastrophe of September 1st, 1923. In September, 1927, four years after the earthquake, it was estimated that more than 60 per cent. of the total project for reconstructing Tokyo and more than 70 per cent. of the programme for recreating the city of Yokohama had been completed.

ONE of the most serious accidents in the history of the construction of the new Welland Canal occurred, according to the *Engineering News-Record*, on August 1st, when one of two cranes working on the lock wall of Lock No. 6 placing the end post of one of the gates overturned, and in falling between the lock wall and the gate upon which it was working upset the gate, causing it to fall across the canal lock chamber, striking the opposite gate and then collapsing upon the floor of the chamber. Six of the workmen were killed instantly, four subsequently died from injuries, and about twenty-four other men were injured.

THE problem of transmitting electric power to the industries of Central and Southern Sweden from the enormous water power reserves of the North has become one of the important industrial problems of Sweden. Of Sweden's nine million available horse-power of water seven millions are situated in Norrland. Of this only 6 per cent. has so far been exploited, and Norrland waterfalls still have immense power reserves to supply to the industry of Sweden. The water power of Central and South Sweden is already largely utilised, and the demand for power is growing continuously, so that, unless further steps are taken to transmit power from the North, industry will have to go seriously short.

THAT Germany is fully alive to the possibilities of electrical illumination as a means for attracting visitors is revealed by the fact that a report is current to the effect that in October next a determined effort is to be made to out-rival both Paris and Vienna. For one week during each month, states the *Electrician*, Berlin is to be bathed in a sea of electric light, even shopkeepers entering into the spirit of the campaign with numerous electric signs and floodlights. It is understood that no fewer than 900 searchlights are to be installed, while most of the prominent buildings will be floodlighted. The purpose of this illumination campaign will be to attract foreign visitors to Berlin—visitors who hitherto have spent their money in either Paris or Vienna.

IN the foothills of the Allegheny Mountains, near Lake Wallenpaupack, Pa., where engineers of the American General Electric Company have been co-operating in experiments and investigations on the 220-kV transmission lines of the Pennsylvania power and light system for more than three years in an endeavour to ascertain the characteristics of lightning, a photographic record has been obtained showing the nature of a lightning stroke on transmission wires before reaching the ground. This is the first 220-kV line built in a territory subject to frequent violent thunderstorms. This picture was taken at Friday noon, July 27th, and reveals a stroke on the transmission wires of approximately 2,500,000 volts. It was made automatically by a cathode-ray oscillograph developed in the general engineering laboratory of the General Electric Company.

INFORMATION regarding telephones in Sweden, extracted from the Statistical Report of the Swedish Telegraph Department for 1927, shows that in 1927 the number of telephone stations was 4735, of which 28 were private. Two automatic telephone exchanges are being built in Stockholm and one in Gothenburg. Telephone conversations numbered 694·6 millions in 1927, as against 662·1 millions in 1926; of these 317,000 were to foreign countries, against 308,000 in the preceding year; 298,000 from foreign countries, against 276,000 and 60,000 through Sweden, against 56,000 in 1926. Of 615,000 telephone conversations with foreign countries, Denmark accounted for 260,500, Norway for 197,500, Germany for 126,000, and Great Britain for 3200—first year of traffic. Telephone traffic was opened up during the year with Great Britain, France, Belgium, and the Netherlands. The number of telephones, including extensions, in use in 1927 was 453,513, or 74·5 per thousand inhabitants, as against 438,059 in 1926. The income derived from telephone traffic in 1927 was 75,003,000 kroners, as against 72,335,000 kroners in 1926.

Miscellanea.

IT is proposed to establish an iron industry at Puerto Corral, Chile.

A STRIKE of asbestos is reported to have been made in the Vukwe area of the Tati Concessions, Rhodesia.

THE new laboratories of the Safety in Mines Research Board at Sheffield are now being taken into service.

SOME American engineers are now on their way to Kuznetzk, Siberia, to install there an iron and steel works.

WORK has been started on the construction of the by-product plant of the British Benzol and Coal Distillation Company near Bedwas Colliery.

THE first unit of the plant of Continuous Coal Carbonisation, Ltd., at Erith, is nearing completion, and it is hoped to start production early in September.

THE new tariff for electric supply from the Witbank power station, Transvaal, is £5 10s. per kVA of maximum demand per annum, plus 0·06d. per unit consumed.

BLAST-FURNACES, steel rolling mills, and a large power station are included in the plans for new works at Dagenham, on the Essex side of the Thames, for the Ford Motor Company, Ltd.

TWO new powerful pumps have been installed by the Calcutta Corporation for dealing with storm water in the Manicktollah area, and two more are to be added soon after the rains are over.

THE electrical plant at Port Elizabeth, South Africa, is to be extended by the addition of a 3000-kW and a 10,000-kW turbo generator. The expenditure on the extensions is estimated at £350,000.

IN granting experimental television licences to applicants, the American Federal Radio Commission states that the licences are "subject to revocation unless the applicant makes satisfactory progress in the work."

THE Sutherland Dock at Cockatoo Island, New South Wales, is to be extended in length from 602ft. to 690ft., and in width from 84ft. to 88ft. At present there is no dock in Australia which will accommodate a vessel of 85ft. beam.

THE Government of British Columbia has appropriated 12,000 dollars for an investigation into the practicability of the use of pulverised coal for small steamships. The investigation will be carried out in co-operation with the Pacific Navigation Company.

THE number of arrivals of vessels in the port of Calcutta during the year 1927-28 was 1418 and departures 1422, representing a gross tonnage of 7,661,170 inwards and 7,677,864 outwards. The number of ocean-going steamers arriving at Chittagong during the year was 219.

THE Associated Manufacturers of Brass Products in Germany have followed the lead of the wire industry in establishing a joint plant for experimental and research work. The Langenberg copper and brass works at Cologne have been bought by the Association for this purpose.

A COMPANY has been formed in Rhodesia for the manufacture of Portland cement. Suitable deposits of limestone and shale have been acquired at Chipongwe, some 350 miles north of Wankie, and a factory capable of producing 40,000 bags of cement a month is to be erected there.

IT is announced that the Eisen und Stahlwerke Hœsch A.G. at Dortmund is engaged on the construction of a new plating plant and rolling mill at Stockheide, on the Ruhr. In this new mill it is planned that aluminium, and later other metals, will be rolled on ordinary black steel sheets by a special patented process.

THE Federal Public Works Committee is examining plans for converting the Melbourne Central telephone exchange from manual to automatic working. This change would cost nearly £585,000, including over £377,000 representing the cost of the new switching system. If the work is carried out, it is considered that it would meet telephone requirements for the next twelve years.

ONTARIO, the most populous province in Canada, owns twenty-five broadcasting stations, or more than double the number to be found in any other province in the Dominion. Alberta follows with eleven broadcasting licences. Saskatchewan and British Columbia come next with ten licences each, while Quebec has nine and New Brunswick three. Prince Edward Island and Manitoba have two licences each, and Nova Scotia owns one.

THERE is, says the *Industrial Australian*, a possibility that the New South Wales Government may abandon the construction of the Newcastle floating dock. A section of the Ministry feels that the dock may be useless and costly when completed, and that it will not serve the purpose for which it was intended. The State Cabinet has decided to appoint an expert committee to investigate the whole proposal. When a report is received the Cabinet will come to a definite decision.

A FUEL conference, organised as a sectional meeting of the World Power Conference, will be held at the Imperial Institute, London, S.W. 7, from September 24th to October 6th next. It will include sections dealing with the oil industry, the carbonisation industry, utilisation of fuels, including electricity, for industrial furnace work; utilisation of fuels, including electricity, for domestic purposes; internal combustion engines; transmission of power; waste heat recovery; low-temperature carbonisation; training of fuel technicians. The address of the secretaries is 36, Kingsway, W.C. 2.

THE new coke plant of the Montreal Coke and Manufacturing Company, Ltd., a subsidiary of Montreal Light, Heat and Power Consolidated, is, according to the *Iron and Coal Trades' Review*, now in operation, and will have an annual output capacity of 250,000 tons of high-grade coke, 6,500,000,000 cubic feet of gas, 3,500,000 gallons of tar, and 10,000,000 lb. of ammonium sulphate. The new plant has a battery of fifty-nine Koppers coke ovens and a by-product plant for the recovery of tar and ammonium sulphate. About half a million tons of coal will be used in the plant annually. Its gas output will be sold through the mains of the Montreal Power Company.

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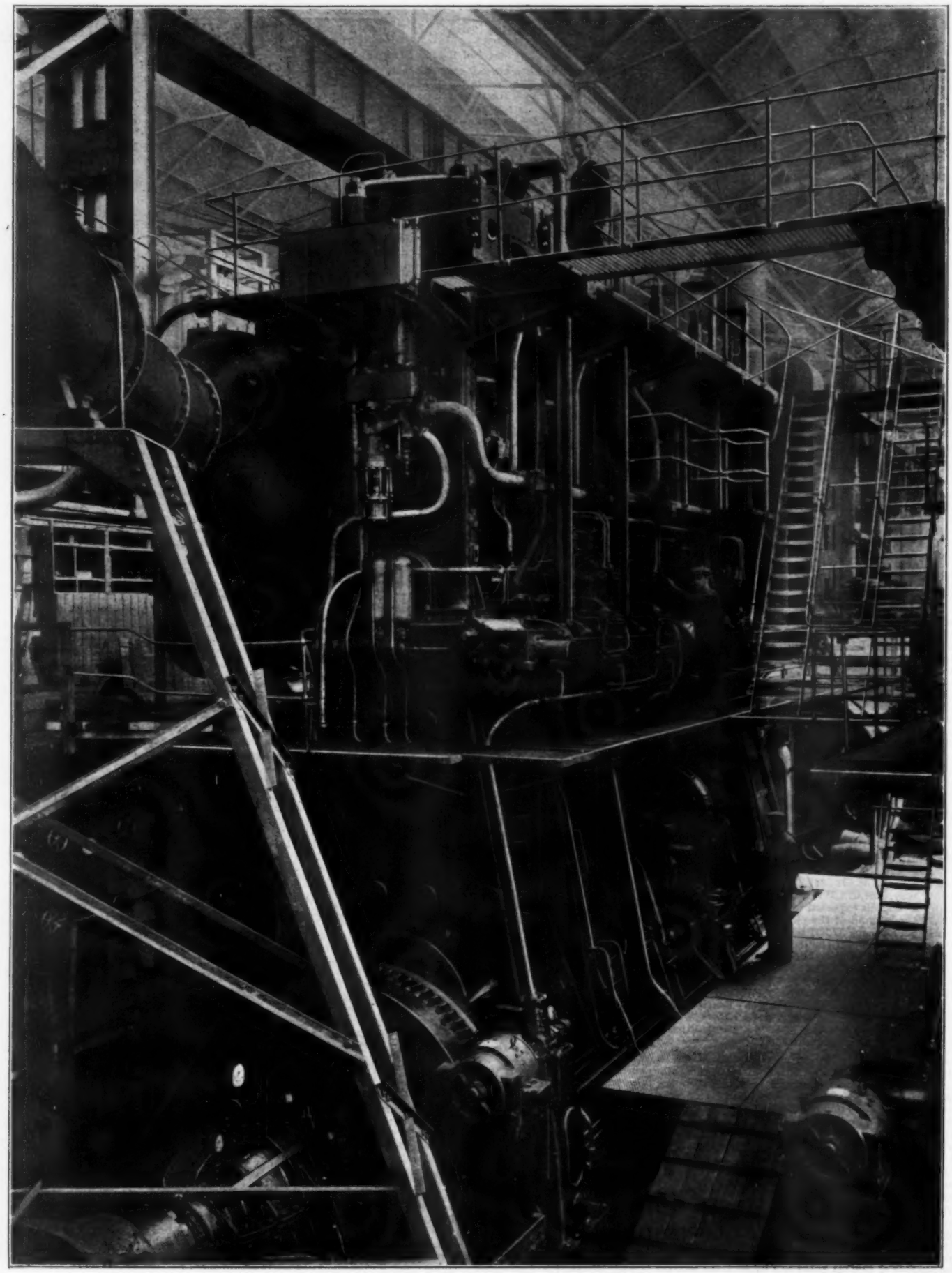
(*For description see page 234*)



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Contents.

THE ENGINEER, August 31st, 1928. PAGE

A SEVEN-DAY JOURNAL .. 217
THE FLEXIBILITY OF PLAIN PIPES. No. III. (Illus.) .. 218
BURRATOR RESERVOIR ENLARGEMENT. (Illus.) .. 220
APPARATUS AND METHODS FOR MEASUREMENT OF THE HERTZIAN HARDNESS. (Illus.) .. 220
A LARGE VACUUM PAPER DRYER. (Illus.) .. 222
INTERNATIONAL CONFERENCE ON BITUMINOUS COAL .. 224
LETTERS TO THE EDITOR—
Recovery of Waste Heat .. 224
THOMAS TELFORD MEMORIAL. (Illus.) .. 225
THE GOVERNMENT AIRSHIP R 101. (Illus.) .. 226
SIXTY YEARS AGO .. 228
RAILWAY MATTERS—NOTES AND MEMORANDA—MISCELLANEA .. 229
LEADING ARTICLES—
Foreign Merchant Shipping .. 231
The Condition of Industrial Research .. 232
LITERATURE .. 232
BOOKS RECEIVED .. 232
ROTARY AND TURBO COMPRESSORS. No. II. (Illus.) .. 233
A 4000 B.H.P. DOUBLE-ACTING TWO-STROKE OIL ENGINE. (Illus.) .. 234
THE SOUTH GERMAN COAL MARKET .. 236
ARCH DAMS WITH RINGS OF VARIABLE THICKNESS. (Illus.) .. 236
BEARDMORE-CAPROTTI MARINE STEAM ENGINES. (Illus.) .. 236
AN OIL SKIMMING PUMP. (Illus.) .. 237
CANADIAN ENGINEERING NEWS .. 237
B.E.S.A. SPECIFICATIONS .. 237
THE SPEED CONTROL OF IMPULSE TURBINES. (Illus.) .. 238
PAVEMENT-TESTING CORE DRILL. (Illus.) .. 238
SOUTH AFRICAN ENGINEERING NOTES .. 239
PROVINCIAL LETTERS—
The Midlands and Staffordshire .. 239
Lancashire .. 240
Sheffield .. 240
North of England .. 240
Scotland .. 241
Wales and Adjoining Counties .. 241
PERSONAL AND BUSINESS ANNOUNCEMENTS .. 241
CONTRACTS .. 241
CURRENT PRICES FOR METALS AND FUELS .. 242
FRENCH ENGINEERING NOTES .. 243
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 243
FORTHCOMING ENGAGEMENTS .. 244
LAUNCHES AND TRIAL TRIPS .. 244

SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

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The Metallurgist.

THE AUGUST NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

AUGUST 31, 1928.

Foreign Merchant Shipping.

THE mercantile marine on the Continent is undergoing changes of a more important character than is that of this country. It develops under different conditions and it has to meet special requirements, rendered necessary by a legislation which favours the ownership of vessels of home construction, to the detriment of foreign-built ships. In the case of French shipowners, the legislation places burdens upon them in the form of what are regarded as excessive charges and an eight hours' working day, that place them in an unfavourable situation to compete for freights. In all maritime countries efforts are made to secure for the merchant fleet a monopoly of the home carrying trade, and as shipowners and builders labour under disabilities the Governments are coming to their aid. Existing shipyards have been extended and new ones created. In France alone the capacity of the shipyards is 30 per cent. more than it was before the war. The fleet must therefore be developed as a means of helping to promote an economic prosperity and of providing work to the shipyards. The French Government has instituted a credit system for shipowners whereby a total sum of 1000 million francs will be placed at their disposal at a low rate of interest during a period of five years. At the same time, material for the construction of merchant ships can be imported free of duty, and owners are authorised to place orders in foreign shipyards if the French prices should be more than 15 per cent. above those quoted by foreign builders. Italy is doing much to favour the development of her mercantile marine. Spain has awakened to a desire for economic expansion, and is endeavouring to revive her glories as a maritime Power by constructing a fleet of big and fast liners which will be put into service on the two Atlantics. Her navy having been curtailed, Germany has had to concentrate on the mercantile marine. In general, tonnage is in excess of the freight requirements, and now that modern ships are increasing in number it is found that the old vessels are out of the running. Those countries which depend upon an importation of steam coal are trying to dispense with that fuel. An active policy of modernising fleets has therefore become general on the Continent, where the question of national defence is not overlooked in view of the possibility of enabling transports to protect themselves against the attacks of submarines. The equipment of the "Ile de France" with an aeroplane platform for the delivery of mails before arrival on each side points to developments which may add considerably to the protection of transports in times of hostilities. It is a logical outcome of the desire to combine economical working with a certain defensive power, that attention should now be given to the oil-engined ship designed to offer some protection against submarines and aircraft. As bigger crews have to be carried in French ships on account of the operation of the eight hours' working day, the certainty of being able to reduce the number of hands by the substitution of oil engines, is regarded as a strong argument in favour of the motor ship. As the success of oil-engined transports depends upon always obtaining sufficient supplies of fuel, it is obvious that the future of the merchant marine in France will be influenced to a certain extent by the efforts now being made to ensure supplies of home-produced oils.

While the United States merchant fleet has undergone a rapid development of late years, the percentage of shipping owned by Great Britain has necessarily declined; but there has been, in this country as well as elsewhere, an appreciable increase of tonnage as compared with that of 1913, with the sole exception of Germany. The losses of the war have been made good and the capacity of the foreign shipyards now far exceeds present needs. This implies a competition which has involved some yards in heavy losses. German shipbuilders hoped to secure an advantage over their foreign competitors by applying the system of "rationalisation" to the industry, but there are difficulties in the way because shipbuilding is less able than anything else to be tied down to arbitrary production methods, and the German shipyards are now, for the most part, in a particularly unsatisfactory position. One German shipping company is reported to be withholding a contract for six vessels. To a certain extent the new constructions are of a tentative character. The great shipping companies cannot stand still. They alone make progress by adopting every new advance in marine engineering which will contribute to economy and efficiency, as well as to the comfort and convenience of passengers, and, fortunately, all these factors fit in naturally with the general scheme of improvement. Oil fuel, internal combustion engines and pulverised coal all aim at material economy and personal comfort. Progress in the design and construction of big liners cannot bring prosperity to the shipyards generally unless a similar advance is made in other classes of shipping. More than one-half of the world's merchant fleet is composed of vessels of less than 1000 tons, and 28·7 per cent. of the total tonnage comprises steamers and motor ships of between 4000 and 6000 tons. Shipbuilding prosperity therefore depends upon freights. It cannot be said that there has been any notable diminution in the tonnage of vessels entering and leaving the continental ports. In a general way the tonnage has increased, while at some ports like Hamburg the improvement has been particularly marked. Nevertheless, freights have contracted, and, so keen is competition, that shipowners are confronted with the problem of realising immediate economies. In most of the French ports large numbers of old steamers are laid up because, under present conditions, they are no longer profitable. They are victims to the attempt to restrict international trade relations by fiscal barriers which seek to limit the importation of goods and produce of all kinds. The carrying trade cannot expand freely until there is a freedom of trade, and as there is apparently little hope of an early change in the world's fiscal policy, shipowners must adapt themselves to a state of things which implies insufficient freights for the total tonnage at present available.

The future of continental shipbuilding, therefore, depends upon the evolution which is taking place in the merchant marine. It is obvious that the marine must follow the universal law of economy. So urgent is the necessity for enabling shipowners

to secure a fair share of the carrying trade that there is some prospect of their being relieved of certain of the charges at present imposed upon them, but that will not reduce their costs of working the ships, many of which would probably not be running at all if they did not enjoy a monopoly of the colonial carrying trade. Where so much depends upon economy it becomes necessary to build new ships which will save fuel and wages and provide larger cargo space and more comfortable accommodation for passengers, for the "mixed" ship is indispensable in some of the continental, and particularly in the French, merchant marines. While Governments are offering every inducement to shipowners to modernise their fleets, the owners themselves hesitate because they do not see exactly where the evolution of the marine is tending. Nor are they much impressed with the offers of financial aid in the form of loans at low interest, for it is quite possible that in accepting the loans under present conditions they would lose their advantage in the event of an improvement in the financial situation. Therefore, it is by no means certain that the State attempts to modernise merchant fleets will of themselves produce the desired result. Nevertheless, the trend of opinion amongst French shipbuilders is strongly in the direction of the motor ship. The fact that the world's tonnage of such vessels increased from 4,270,000 tons in 1927 to 5,432,000 tons in 1928 proves that the advantages of the internal combustion engine for certain conditions of navigation are now recognised, and the orders which have been given out to continental shipyards during the past few months point to a further activity in the early future. The Messageries Maritimes Company has ordered a third motor ship, this time of 21,000 tons, and the Compagnie Générale Transatlantique has ordered one and proposes to construct several others. In view of the new requirements of the merchant marine, the outlook for shipbuilding is encouraging. Still, the elements of competition are greater than ever before. The increased capacity of the continental shipyards has tempted shipbuilders to quote very low prices. There is, nevertheless, no reason why this competition should affect seriously the position of British shipyards. The continental yards are usually situated at quite long distances from the sources of iron and steel supply. The French builders have been greatly handicapped by the necessity of procuring material from the East of France, but as, under the new State aid scheme, they will be able to import such material free of duty, it is possible that British industry may profit from the development of the French merchant marine. In Holland and Germany shipbuilders benefit from low water-borne freights, but they are less favourably situated than builders on the Clyde and in the North of England, where the raw material is close at hand. The prime factor in continental competition is the lower wages. It is a tribute to British shipbuilding that, despite this disability, it should more than hold its own against the competition of foreign shipyards.

The Condition of Industrial Research.

There is a widespread lament that research is not adequately supported by industrial undertakings. The blame for this state of affairs is generally put on the shoulders of industry. Manufacturers are reproached with a want of appreciation of the benefits which science may bring them, with an unwillingness to contribute to investigations fundamental to the continued prosperity of their industry, and, generally, with a stubborn blindness to their own interests. Such general charges are unjust. In saying this we do not rely on the well-known munificence of certain industrial leaders towards universities or other institutions devoted to the advancement of science. Men who can and will assist science in this way will always be comparatively few. They can therefore be left out of consideration for the moment, or, better, they can be offset against the equally small number of men who, owing their position in industry to the merits of their ancestors, imitate the latter in everything except the enlightenment of mind which built up their business. We would rather base our defence of manufacturers generally on the ground that men in charge of industrial undertakings, whether great or small, are, on the average, men of high intelligence. Their scientific attainments may not be great, but knowledge of the processes of the laboratory or the methods of the mathematician is not a matter of intelligence in the widest sense, but of specially directed study. What the average managing director does know, by hypothesis, is his business and its requirements. He has, moreover, both a professional and financial incentive to take advantage of every scrap of knowledge which can promote the interest of his firm. Being intelligent, he understands full well that knowledge, like everything else worth having, has got to be paid for, and as a business man he is prepared to pay as much and no more than it is worth to him.

If we have sufficiently depicted the mentality of the average chief of an industrial undertaking, we may consider what passes through his mind when he is asked to contribute money for research. In the first place, he will not be likely to respond to any appeal which conjures up in his thoughts a picture of a number of young men "pottering about" in a laboratory hoping to find out something, they don't know what, which may be useful to an industry of which they know nothing. Nor will he be moved by any statement as to the great discoveries which have been made by scientific men accidentally, so to speak, and applied to industry afterwards. Most of such discoveries consist, not in the happenings themselves, whether they be accidental or otherwise, but in the deductions drawn from them. It was not the sight of a falling apple which led to our knowledge of the Law of Gravitation, but the reflections of Newton upon it. Industry would bear the cost of providing hundreds of tea-kettles for as many potential Watts, or all the apparatus they might require for embryo Faradays, Thomsons, or Rayleighs, if only the requisite calibre of the recipients could be assured. Such men, however, are too rare to bear any large part in "research" as commonly understood to-day. When they do appear, they follow their own lines of genius, producing their results with the tools of the mind rather than with the appurtenances of the laboratory. Their achievements have little bearing on commercial research, except perhaps to show, by the simplicity of the apparatus which has usually sufficed them, how much more scientific progress is the outcome of intellectual ability than of laboratory furniture. Their work, moreover, is almost always of the nature of "fundamental" research. We are, therefore, not concerned with it at present, other than to commend it on the grounds that it increases human culture and gratifies the intellectual desires of man. Any appeal to industrialists to support it on the usual plea that one can never tell what commercial purpose it may serve in the future is not very convincing. The only kind of research on which the head of an industrial undertaking would be justified in spending his shareholders' money is that which is directed definitely to the provision of some information of immediate importance. Such research falls into two classes. That of one class he would be very reluctant to entrust to anyone outside his own staff, desiring, for reasons easily understood, to keep the results in his own hands, whether successfull or not. Research of the other kind is concerned with questions affecting the industry as a whole, and especially the elucidation of facts about which everyone should be agreed. In this class come such matters as the determination of physical constants, the tabulation of the properties of steam, the cause of brittleness in boiler plates, the tests for lubricating qualities of oils, and so on. There are, of course, numerous border line questions. The boiler-making industry, for example, might well consider that the development of a steel to stand very high temperature was a fit subject to warrant the subsidising of a common research, while many steel makers might like to make their own private researches into the matter.

For the research associations to get the desired financial support from manufacturers, they must come before them with a perfectly definite programme of work of recognised utility, if not of necessity; a programme of a kind to appeal to practical men and with nothing vague about it. Until a problem can be stated explicitly it is not one for an industrial research association. To say "We are going to try to find a better paint, or a better refractory, or a better tool steel," for example, is not convincing enough. It savours too much of "pottering about." Change it to "We propose to carry out a definite series of experiments with various proportions of such and such ingredients, because theory or judgment indicates that among these variations an improved material may be found," and the proposition at once takes on a different complexion. It can then be considered fairly on its merits by men competent to appraise the value of the object in view, and the means proposed to attain it. Even should the most probable path to success appear far from hopeful, support may still be obtained for the work because, whether or not the desired goal is attained, the knowledge accumulated by the systematic and careful experiments will certainly be well worth having by the industry. One of the reasons for the apathy towards research under Government auspices is undoubtedly a want of faith in the utility of the work being done or a lack of confidence in the competence of the men undertaking it. It would be wrong, however, for manufacturers to let their dissatisfaction with some of the work of the existing research organisations blind them to the fact that there is an enormous amount of research which can best be carried out by co-operative effort. Their duty is to support the organisation, not only with money, but with the much more valuable aid of personal interest and guidance. They could easily bring enough influence to bear to eliminate "scientific pottering," and to guide the work along lines which would lead to results of real value to industry.

Literature.

A Treatise on Chemical Engineering, Applied to the Flow of Industrial Gases, Steam, Water and Liquid Chemicals, including the Pneumatic Transport of Powders and Granulated Materials, &c. By Geoffrey Martin, D.Sc. (Lond. and Bristol), Ph.D., F.I.C., &c. &c. London: Crosby Lockwood and Son. 1928. £3 3s.

This volume will be extremely valuable to chemical engineers and works chemists who are faced with the problems which the author has dealt with almost every day. It is a treatise on the practical physics of fluid flow in conduits, with lucid theoretical proofs as a basis for calculating plant, and in spite of the title, the actual engineering side is hardly treated at all. The problems of fluid flow, an expression coined by the reviewer to include all the states of aggregation, are well known to the physicist *ex professo*, but the chemical engineer and the chemist advising the works engineer will find in this book something, and almost everything about that something, which he has been forced to search for in what amounts to a small library. In his preface, maybe, the author underestimates the knowledge of his forerunners, even in the Portland cement industry, as the flow of gases at least has been very well understood by, at all events, some of those responsible for furnace design for a great many years, while, in sulphuric acid manufacture by the chamber process, the economics of the various gases was brought practically to perfection by Lunge, Hurter, and others. On the other hand, the treatment of problems relating to air and liquids conveying solids have only been subjected to mathematical treatment for a comparatively short time, as also has the physics of the limiting velocities determining change from stream-line to turbulent flow of liquids, and in general what used to be called eddy losses.

The author's treatment of the determination of velocities of gases is probably the most exhaustive one to be found in any text-book. To begin with, the Pitot tube is explained, together with the various forms of manometers, to lead up to a short chapter on the distribution of velocities in pipes, &c. Then follows the viscosity of gases and liquids, the definition and theory of which are given in a simple lucid way—in fact, masterly compared with most—again to lead up to the use of the Pitot tube for the determination of the modulus of viscosity. One might perhaps say computation, as the author takes flow in smooth, cylindrical pipes as an illustration, giving acting pressure, counter pressure, and temperature. That the pipe itself is a limiting case of the Venturi throat is left to the reader to conjecture. Anyway, the departure serves to introduce the similarity or maybe identity in this respect of the flow of gases and liquids.

A similar case is made out in the case of limiting speed for change from stream-line to turbulent flow, and the author carries this principle of uniformity of the different phases of flow for gases and liquids right through the book. There is undoubtedly an advantage in this method of unification, if the reader notes the departures from the time-honoured definitions of frictional quantities, &c., as it enables the busy worker to remember practically the whole of the essentials sufficiently to reconstruct the necessary formula without much effort as long as he sticks to the C.G.S. units.

What useful purpose the elaborate reiteration of the same things in British units can really serve is difficult to see. You have, after all, the conversion into practical metric quantities for nothing, and the reduction of the *final* results into British units is an easy matter.

A departure from the general scheme is made in a chapter on the mensuration of the viscosity of liquids, which is treated in the ordinary way, but without any proof of Poiseuille's formula. It is gratifying to note the conversion of results into, and their tabulation as, absolute units. Chapter XVI. on the calculation of work done and horse-power required to force fluids through conduits against pressures finishes the first part of the book dealing with general principles

and uniform conditions. Chapter XVII. on Bernoulli's theorem starts a more ambitious part, treating the problems involved as summations of energy quantities, although Bernoulli put his theorem differently, roughly a century before the principle of conservation of energy was formulated.

The author does not, however, work out a general theory of a system of pipes and conduits with varying cross sections, bifurcations, temperatures, &c. &c., as one might have expected, but confines his practical examples to the Venturi "throat," and other methods of measuring total flow by local contraction of the conduit, and to detailed losses due to various constructional elements. In practice the pipe systems in chemical works are utterly complicated, such as, say, the acetone recovery plant of an artificial silk factory. Here the air carrying the valuable vapour is collected from thousands of spinning cabinets, sucked and forced successively through ever-growing pipes into main drums leading to artificially cooled condensers, and from there to scrubber plants, &c., before eventually being discharged into the atmosphere. The book is a valuable help in treating such a problem, but the individual who has to do the fundamental calculations must, besides such a welcome aid, possess that rare gift which may be called mathem tical instinct, if he is to choose the best alternatives which will suit existing plant, and probable future expansion as well. A great part of the end of the book is devoted to problems relating to steam which are quite fam liar to engineers and to be found in many other text-books. This, as well as the duplication of units and the consequent tabulated matter might have been excluded, and a complete system of plant familiar to the author substituted, giving his method of arranging his basic facts and computations.

The final chapters on the conveying of solids by liquids and gases having velocity, excellent as they are from a theoretical point of view, might in that case have been furnished with some practical illustrations. Still, on the whole, this book is one of the best contributions to text-book literature which has appeared for many years, and the author's experience is such that he must have met almost every problem treated in actual practice, of which there is ample proof in his choice of specimen calculations and mode of procedure. The only real fault to be found with the book is the duplication of the text to introduce British units, which the author says he has done after much consideration. He sees himself that this is not needed by a modern chemical engineer, who simply must know the C.G.S. system, and the international value and appreciation which this book thoroughly deserves is discounted, as is also its "readability" to a man of science, who never uses British units, except for ordering commercial requisites. Printing in different type might raise the ire of some readers, and the reviewer is inclined to believe that a complete deletion would suit most of those whose work actually involves using the book.

On the other hand, this book has an outstanding merit which is very seldom to be found in a text-book, viz., it gives the theoretical deduction of the most elementary formulæ, including that of the velocity of fluids issuing from an orifice under pressure. Some readers may look upon this as a slight to their intellectual status, but it is strange how often even the most experienced calculator has to look up such things as these in Ganot's physics or some other similar old friend. By this departure the author has made his book self-contained, and given it a completeness which is a recommendation by itself.

BOOKS RECEIVED.

Bradford Technical College: Diploma and Special Day Courses, 1928–29. Bradford: Bradford Education Committee.

Journal of the Franklin Institute. August, 1928. Lancaster, Pa.: Published by the Institute, Prince and Lemon Streets.

Studies in Magnets and Magnetism. By R. Wild. London: Arthur H. Stockwell, Ltd., 29, Ludgate-hill, E.C. 4. Price 2s. 6d. net.

Gentlemen Prefer Aeroplanes! By E. F. Spanner. London: E. F. Spanner, 9, Billiter-buildings, Billiter-street, E.C. 3. Price 35s. net.

The Elements of Hydrology. Second edition. By A. F. Meyer. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 25s. net.

Bulletin of the British Cast Iron Research Association. No. 21. July, 1928. Birmingham: Published by the Association, 24, St. Paul's-square.

Durban Corporation: Water Engineer's Report for the Municipal Year ended July 31st, 1927. Durban: Hayne and Gibson, 31, Field-street. 1927.

L'Enseignement Technique, Bulletin Mensuel du Musée Professionnel de l'Etat à Morlanwelz-Mariemont. Juin, 1928. Morlanwelz: Published at the Museum.

Bulletin of the Hydro-electric Power Commission of Ontario. Vol. XV. No. 7. July, 1928. Toronto: Published by the Commission, 190, University-avenue.

Annali dei Lavori Pubblici (già Giornale del Genio Civile), Ministero dei Lavori Pubblici; Consiglio Superiore. Maggio, 1928. Rome: Provveditorato Generale dello Stato, Libreria.

Mechanical and Physical Properties of Timbers: Tests of Small Clear Specimens. By C. J. Chaplin, M.Sc. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. net.

Rotary and Turbo Compressors.

No. II. (*Conclusion*).*

COOLING.

THE matter of cooling is quite an important one in the case of turbo compressors, and formerly caused a good deal of trouble. In this connection it should be noted that, in the reciprocating compressor, the temperature at the end of each stroke will never exceed that due to adiabatic compression, whereas, in the turbo type, the maximum temperature which is realised at the outlet from the diffuser blades is generally above the adiabatic value. This is mainly due to skin friction between the impeller discs and the casing walls. The result is that the mean density of the fluid during its passage through the impeller is reduced, and this in turn adversely affects the delivery pressure as well as the energy absorbed at the compressor shaft. For these reasons the most thorough and efficient cooling becomes necessary when pressures exceed about 30 lb. Formerly, jacketing the casing sufficed for the purpose, because the pressure rise per stage was relatively low and the total capacity of the earlier designs being small as compared with the number of stages, the amount of heat per stage could be easily abstracted between stages by the simple expedient of water jacketing the whole. A gradual reduction of the number of stages to a maximum of about ten has rendered such methods inadequate, as a temperature rise of as much as 80 deg. per stage may have to be dealt with. At the present day, inner cooling is largely adopted by builders of turbo compressors of large output as being preferable to intermediate outside coolers,

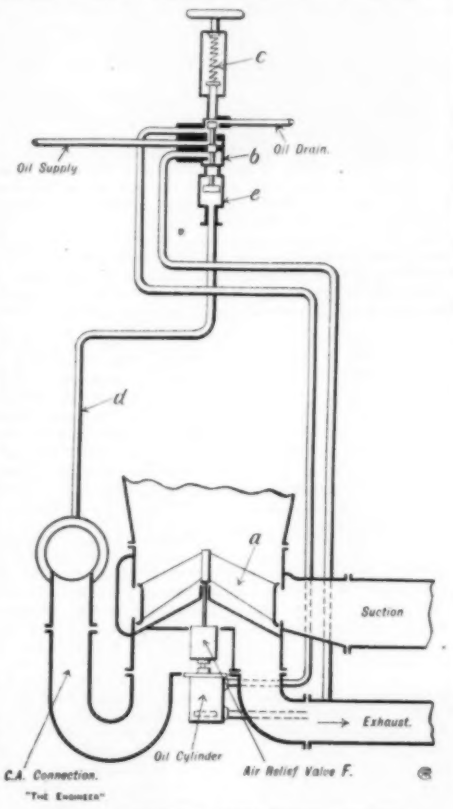


FIG. 11—ADAMSON UNLOADING DEVICE

which tend to deflect the air from its even distribution around the shaft, with appreciable loss. In a modern machine the intermediate walls of the casing are, as already mentioned, hollowed out and provided with large water chambers, by means of which the heat of each stage is instantly led away from where it originated. Leakage into the air system is eliminated, as the joints to be kept tight are small and the length and width of the compressor are reduced. At the same time it must be conceded that there are still adherents to the external cooling system, notably Messrs. Brown Boveri and the B.T.H. Co. They claim, and with some justification, that internal cooling involves complicated castings and inaccessible water spaces, and this certainly is the case, though the difficulties appear in practice to have been successfully overcome. External cooling does obviously simplify the casings of the compressor itself, and the external system has the advantage of precipitating a large amount of the moisture entrained in the air, which can be drawn off. As regards the construction of external coolers, little need be said, as they are built on the surface condenser principle and are usually placed in sets of three on each side of the lower half of the casing at an angle of 45 deg. with the vertical. The top covers are at about floor level and they are very accessible for cleaning, which can be done without stopping the machine.

REGULATION.

Under operating conditions which do not call for a variation of the air supply below about 75 per cent. of full capacity or over 110 per cent. above it, it is a relatively simple matter to make use of the increased pressure consequent upon reduced demand to actuate a regulator which operates on the throttle valve of the turbine, slowing it down in proportion to the reduced air delivery. In order, however, to meet demands varying from no load to 110 per cent. load, some form of unloading device is called for. That adopted by Daniel Adamson is shown in Fig. 11.

It takes the form of an air-pressure-regulated, oil-operated suction valve, which closes off the suction main at the same moment as a non-return valve on the air delivery main closes. The compressor being shut off from the air system, the suction valve permits of the circulation of a small quantity of air at atmospheric pressure, which serves to insure sufficient cooling during any lengthy period of running under conditions of non-delivery. During this period of running light, the load is at a minimum, and, if turbine-driven, the machine can be adjusted by hand to its lowest speed. The suction valve *a* is controlled by the piston in the oil cylinder *b*, and is opened by the oil pressure when the relay piston is in its lowest position. The relay piston is kept in its normal position by a spring *c*, which can be hand-adjusted. From the compressed air pipe, pressure is led by the pipe *d* to the air piston *e*, and, when this air pressure increases above a certain maximum, as it would do on reduced demand for air, it lifts the relay piston against the pressure of the

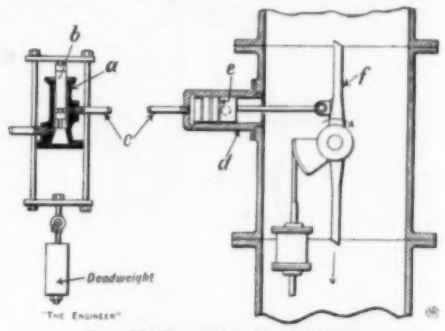


FIG. 12—PARSONS REGULATOR

spring. The suction valve then closes downwards. As it does so, however, the air escape valve *f* comes into action, allowing compressed air to escape from the machine. The relay piston can be held up by means of the hand adjustment during starting up, so that the compressor may be run up to speed light without compressing air. The same arrangement is applicable if the drive is by alternating-current motor, but with a direct-current motor, the usual speed regulating gear can be controlled by the air pressure.

The regulating system as installed on the Parsons compressors, is shown in Fig. 12.

The cylinder *a* contains a piston *b* loaded by a deadweight. The cylinder is connected by the pipe *c* to the cylinder *d*, in which the piston *e* serves to operate the suction throttle valve *f*. Air from the delivery main having access to the cylinder *a* through the pipe on the left will overcome the weight with which the piston *b* is loaded, and, by raising it, gain access to cylinder *d* and so close the suction.

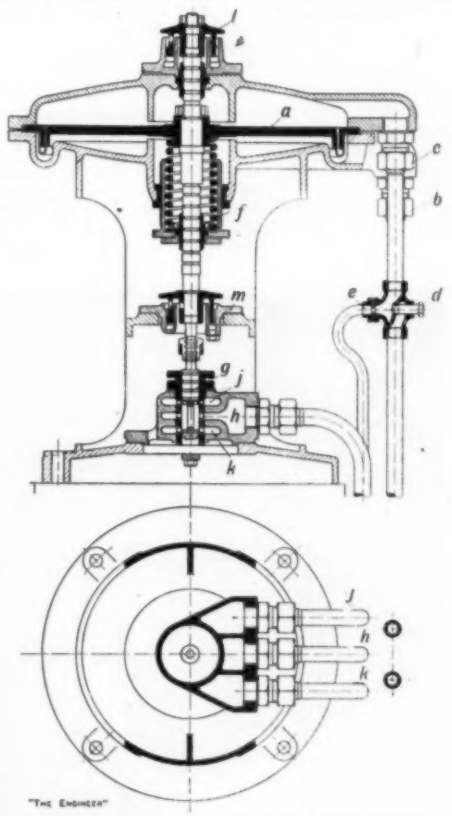


FIG. 13—AIR-OPERATED BLOW-OFF VALVE

When the pressure falls to the normal again, the piston *b* falls, and the air accumulated behind the piston *c* escapes through holes drilled in *b*. The rate of release is controllable by a needle valve, and by this means the pressure variation when the governor is in action may be reduced to a minimum.

In conjunction with this equipment a non-return valve is fitted on the delivery. It takes the form of a series of metallic disc valves, and, on the compressor side of it, is a relief valve. This opens automatically when with throttled suction the air delivery is reduced in pressure, so that with the regulator in action, the impellers run in a partial vacuum with the compressor outlet open to atmosphere. This obviates churning of the air, which would cause overheating.

BLOW-OFF VALVES.

A blow-off valve itself may be quite a simple component, but on a compressor of any considerable output some form

* No. I. appeared August 24th.

of automatic control is called for. The valve should only be operated when absolutely necessary, and its control should therefore be so adjusted that it always begins to lift immediately before the surging limit is reached. In the case of the Brown Boveri machines, which employ this system, this condition is effected by a relay acting under the influ-

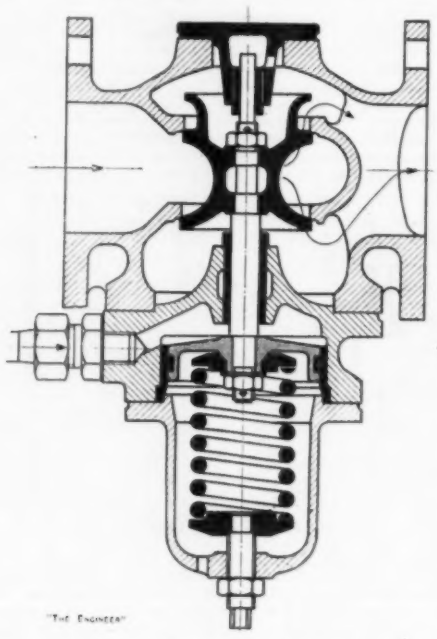


FIG. 14—SUBSIDIARY VALVE

ence of both volume and pressure. It may be air-operated or oil operated. The essential features of the air operated system, which do not vary greatly from those of the oil-operated system, are shown in Fig. 13.

There is a membrane piston *a* with connections *b* and *c*, a regulating valve *d* in the pipe *c* with a baffle *e*, a regulating spring *f*, and a pilot valve *g* with connections *h*, *j* and *k*. The membrane piston *a* is attached to the relay spindle. In order to eliminate friction and disturbing effects owing to lack of tightness, the piston *a* does not slide, but has a rubber membrance around its periphery as indicated. The regulating spring *f*, which is adjustable, not only serves to ensure the necessary degree of stability for the control system, but also to compensate the weight of the movable parts of the relay. An oil dashpot *l* is fitted to the upper extremity of the relay spindle. Its duty is to prevent hunting, but it is also used as an oil cup for lubricating the upper guide of the spindle. A second guide *m*, also immersed in oil, is placed where shown. In conjunction with this relay and connected to it through the medium of the pipe shown on the left is the valve shown in Fig. 14.

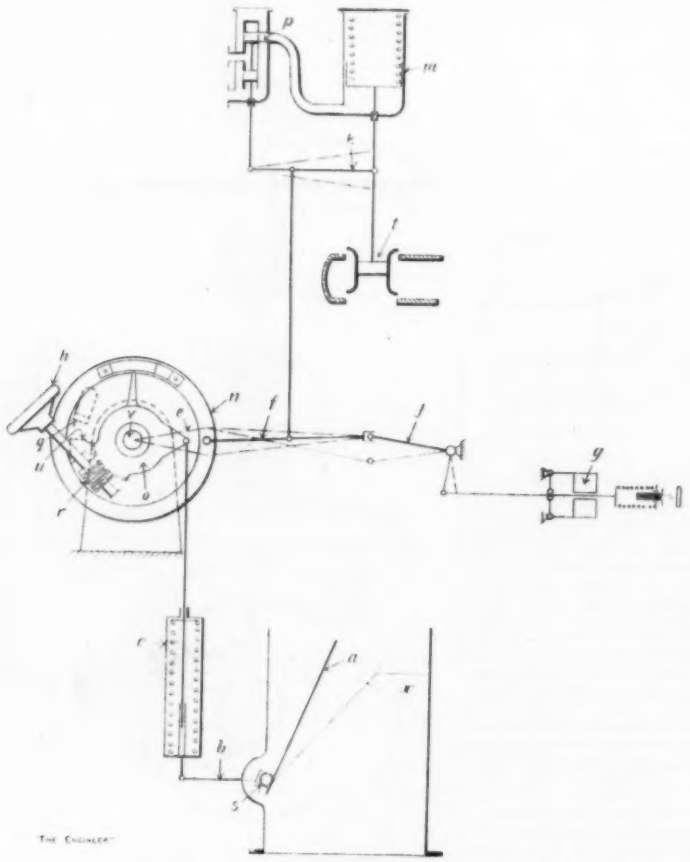


FIG. 15—DIAGRAM OF CONSTANT-VOLUME GOVERNING SYSTEM

The relay is under the influence of both pressure and volume. In respect of the latter, this is effected by allowing the pressure difference produced by the air flowing through a baffle or nozzle to act on piston *a*. Pipe *b* conveys static pressure existing in the middle of the air stream to the underside of the membrane piston, while pipe *c*, which has an extremity directed against the air flow, causes a pressure equal to the sum of the static and dynamic pressures to act on the upper side of the membrane piston. The resultant thrust of the latter is therefore in a downward direction, and is counterbalanced by the spring *f*. In respect of the influence of pressure the baffle *e* should be noted again, as it is by this means that the pressure in pipe *c* is influenced. If the baffle *e* is closed the static pressures on both sides of *a* are equal. If, however, air is allowed to escape through the baffle a difference of pressure on the two faces of *a* is produced with respect to the static pressure which varies approximately in direct proportion to the delivery pressure of the machine. These forces, due to volume and pressure, are opposed to one another but are maintained in equilibrium by the spring *f*. If this balance is disturbed, the relay piston is moved either upwards or downwards, and the pilot valve causes air to be admitted to the servo motor of the blow-off valve, which then opens or allows air to escape to atmosphere, the blow-off valve then closing under the influence of its spring. By suitably adjusting the force of the springs used the opening curve of the blow-off valve can be altered to suit the pumping limit occurring under any given operating conditions.

Constant Volume Control for Turbo Blowers.

A constant volume governing system as designed by Messrs. Fraser and Chalmers, is shown diagrammatically in Fig. 15. The hinged flap *a* in the suction is balanced to assume a definite position for a given flow of air, and its movement is damped by a dashpot at one end of a lever attached to the far end of the spindle while there is an adjustable weight at the other end of the same lever, and its position is permanently fixed after calibration of the governor. At the other end of the spindle *s* is the lever *b* connected by means of *c* to the shaft *v*, which at the turbine end carries the lever *e* attached to one end of the floating lever *f*. The latter is connected to another floating lever *k*, which carries at one end an oil pilot valve *p*, and is connected at the other end to the spindle of the main throttle valve *t*. With the speed governor *g* suitably adjusted, it will act as a speed limiting device. For any point below maximum the connection point between the lever *j* and the floating lever *f* will be a fixed fulcrum. When conditions create a diminished volume of air, plate *a*, moving downwards, moves lever *b* upwards. The shaft *v* will rotate and lift lever *e*, and in consequence *p* which will admit oil to the servo motor cylinder *m* at the same time speeding up the turbine by opening throttle *t*, until delivery becomes normal again. If it is required to regulate the discharge to a definite volume a hand adjustment is made through the medium of the discs *n* and *o*, the latter being movable about its centre by the worm gear *r*. It also has a pointer as shown, indicating the discharge on a scale attached to *n*, and its effect upon the position of *a* with respect to the turbine governor can be traced from the diagram, while the constant volume governor can be rendered inoperative by locking *a* and bringing the stop *q* on the disc *n* against the stop *u*, with which testing the governor will control the blower at constant speed.

Special Types for Blast-furnace Work.

The majority of compressors previously dealt with are suitable for pressures from 50 lb. to 100 lb. Blast-furnace operation calls for large volumes of air, normally at about 10 lb. pressure, but periodically it is necessary to raise the blast pressure to 25 lb. or 30 lb. In conjunction with this particular duty, large gas engines, operated by blast-furnace gas, are particularly well suited to the direct operation of reciprocating blowers, but, when steam is the motive power, the turbine-driven centrifugal blower is entirely suitable for the purpose, although rather special conditions of operation are called into being.

A GREAT loss to railway administration overseas has been sustained by the death on August 18th, from malaria, at the early age of forty-eight years, of Sir Christian Felling, the general manager of the Kenya and Uganda Railways and Harbours. Sir Christian was born in South Africa and joined the railways there in 1895. He rose from the position of a probationer to become eventually chief assistant to the general manager. In October, 1922, he was given the position in Uganda which he was filling when he died, and was responsible for the transportation system introduced there on the recommendation of Colonel Hammond.

A 4000 B.H.P. Double-acting Two-stroke Oil Engine.

IN the issues of THE ENGINEER for March 26th and April 2nd, 1926, we described and gave full test bed trial results of the 4400 B.H.P. six-cylinder, double-acting, two-stroke oil engine which was built at the M.A.N. works, Augsburg, for the motor vessel "Ramses" of the German Australian and Kosmos Lines. A little later in the year we were enabled to announce that arrangements had been made with the Maschinenfabrik-Augsburg-Nürnberg A.G., whereby the M.A.N. two-stroke engine would be manufactured in this country by Vickers-Armstrongs, Ltd., for marine and land use, but that that firm would continue to develop, as heretofore, its own four-stroke engine for both submarine and mercantile work.

On Friday last, August 24th, we were enabled by permission of the Admiralty to inspect at the Naval Construction Works of Vickers-Armstrongs, Ltd., Barrow-in-Furness, the first of two 4000 B.H.P. engines which have been constructed for the submarine repair and depôt ship "Medway," which was launched at Barrow on July 19th, and is now being fitted out.

General Design.

The engine we are about to describe differs in some respects from the standard design of the licensees, mainly with regard to auxiliaries and the special provisions made in order to meet Admiralty practice. It is noteworthy as being the first of its type to be built in Great Britain, although some similar engines have been constructed on the Continent and in America. A view of the port engine on the test bed, looking from the fly-wheel end, is reproduced on page 230, and it shows the general appearance of the engine, the size of which is indicated to some extent by the men who are standing on the starting and service platforms. The starboard set of engines—partly shown to the right of the engraving—is well advanced, and it is hoped in a week's time to run the official trials. For the purpose of testing the engine was coupled through a Michell-type thrust bearing to a Heenan and Froude water brake.

There are four working cylinders, with a bore of 27·6in. and a stroke of 47·25in., which are arranged in two pairs, with the three-stage air injection compressor between the second and third cylinders. The air compressor is directly driven from the main crank shaft, and at the forward end of the engine there is an extended crank, which drives the tandem double-acting scavenge pumps.

Each of the two engines of the "Medway" has a designed output of 4000 B.H.P. at 115 r.p.m. This power, it is estimated, will give the full contract speed of the ship.

The bed-plate is of deep section, and it is so designed that it can be bolted directly on to the tank top. It also forms an oil-tight reservoir for the lubricating oil, which passes from the sump to a drain tank. We noted that a semi-built-up type of crank shaft is employed. It is carried in round-bottomed bearing shells made of white metalled steel, with a pair of deep section cast steel bearing caps. The provision of two caps, it is claimed, gives easy access to the bolts and caps, and it has a further advantage that the bearing caps are more convenient to handle. The connecting-rods have forked upper ends, and, as in the crank shaft, the top and bottom bearings of the rods are fitted with white metalled steel bearings. Between the lower columns at the inboard side of the engine are the slipper guides for the cross heads, which are uncooled. They help to form a stiff bracing for the engine structures.

As shown in the engraving on page 230 there is an entablature above the lower columns to which the cylinder casings are attached. The cam shaft is arranged along the front of this casting, and, as shown in Fig. 2, the fuel pumps are mounted immediately above the cam shaft and are driven from it.

The liners of the cylinders are in two halves, an upper and a lower, and they meet at the centre of the cylinder in a zig-zag joint. As the bottom liner, together with its cylinder casing, are attached to the lower entablature, and the upper cylinder liner is secured to the top entablature shown in Fig. 1, and depends from it, allowance is made for expansion at the middle joint. The exhaust and scavenge ports are arranged at the back of the engine, about the centre of the liner, and they extend nearly half-way round the cylinder wall. Their shape is such that the scavenge air, which enters the cylinder at a pressure of about 2 lb. per square inch, is deflected across the face of the piston, and then up the wall on the opposite side of the cylinder. It then passes across the face of the cylinder cover and down the same wall through which it entered, until the exhaust ports, which are a little nearer the cylinder cover than are the scavenge ports, are reached. The system is one which obviates the use of valves and is found, we are informed, to give good scavenging with a comparatively low pressure of scavenging air.

Fig. 1 shows a view of the upper cylinder covers

looking aft. It will be seen that the covers are deeply cupped. A built-up construction is employed in order to do away with strains, and at the same time to provide good access to the water spaces.

Single central fuel valves are fitted on the top cylinders, while each bottom cylinder has two independently-operated fuel valves. Besides these valves, an air starting valve, a relief valve and an indicating cock are fitted to both the top and the bottom cylinders. These valves, as will be seen from the engraving on page 230, and from Figs. 1 and 2, are worked by push-rods from the cam shaft.

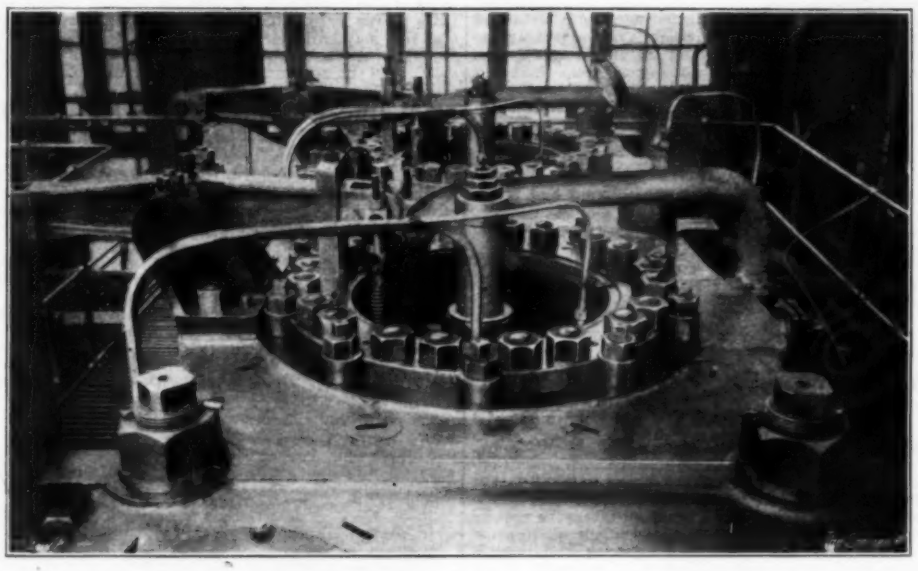


FIG. 1—TOP CYLINDER COVERS AND FUEL VALVES

Each of the four-part pistons, of which the two ends are of cast steel, carries nine piston rings. The single centre piece, which is divided into two parts, longitudinally, is made of cast iron. There is a hollow piston-rod, with an upper collar that is gripped between the two ends of the piston, while the lower end is furnished with a coned connecting piece, which is attached to the cross head. The piston-rod gland is of the gas engine pattern, with cast iron rings, and there is also a light auxiliary packing gland where the piston-rod passes into the crank case. The piston cooling water is supplied to the crosshead through trombone pipes, the glands of which are accessible from outside the crank case. A pipe within the piston-rod itself provides a passage for the cooling water.

The general design of the engine framing is such that the upward impulse or tensile loads are taken by long tie-bolts, extending from the bed-plate to the upper entablature. These bolts are jointed above the lower entablature, and are given an initial tension, which is somewhat greater than the working loads. The compressive stresses are taken by the cast iron columns.

FUEL PUMPS AND AUXILIARY SERVICES.

There are two fuel pumps for each cylinder, and, as shown in Fig. 2, they are mounted in pairs directly above the cam shaft. The drive for the pumps is by means of both spur and bevel gear arranged at the centre of engine. A full description of the fuel pump and its control, along with a sectional drawing, were included in the March 26th, 1926, article, already referred to.

The parts of the engine which are water-cooled are arranged for fresh water cooling, but sea water cooling is retained for the injection air compressor and its "Serck" inter-stage coolers, so that when cruising in tropical waters full advantage may be taken of the lower temperature of the sea. The fresh-water cooling service is maintained by electrically-driven Drysdale pumps of the vertical "Centrex" type, and the lubricating pumps are of the two-throw electrically operated Weir pattern. They supply oil under pressure to all the bearings. For cylinder lubrication mechanically-operated multiple-point lubricators, which are supplied with oil from the raised tank shown at the after end of the engine at upper platform level, are fitted. Directly below this tank will be seen the starting air automatic reducing valves, which ensure that the 1000 lb. pressure air stored in the receivers is reduced to about 300 lb. before it enters the cylinders.

At the same end of the engine, below these valves, is the oil-operated piston, which drives the rack and pinion for moving the cam shaft and bringing the ahead and astern cams into operation. In the same engraving will be seen the single collar Michell thrust block, which is mounted on a well-spread casting bolted to the main bed-plate. This casting also carries the electrically-driven turning gear. This gear is of the double-worm type, and is driven by a "Metro-Vick" motor. It is interconnected with the starting controls. Part of the breeches pipe connecting the exhaust mains to the silencer will be seen in the view on page 230. Immediately below and above the exhaust pipes are the manifolds for the scavenge air. They are made of light welded steel and are directly connected to the cylinders. The air for the scavenge pumps is entrained from a single air inlet connection constructed of perforated steel, which, on the ship, will draw its air supply from a casing connecting with the upper deck.

DEMONSTRATION TRIALS.

The official trials, which comprised a run of eight hours at full power, followed by three days at 80 per cent. of the full power, were run a week or two ago in a satisfactory manner and without incident. On the occasion of our visit the engine was running very quietly on Admiralty Diesel fuel oil and was developing round about 3000 B.H.P. at 110 r.p.m. Opportunities were given to us to see personally the reversing of the engine, its manœuvring, and its slow running capabilities, and also to test the emergency operation of the "Aspinall" type of inertia governor, that may be seen to the left hand of Fig. 3. The arrangement of the various controls is shown in the same view, and perhaps more clearly in Fig. 4. The reversing and starting of the engine is carried out by the movement of a single lever placed at the centre of the engine, on the bottom or starting platform. It moves around a specially shaped cam plate, and the normal running position is in the centre of the slot which divides the plate into two parts in an athwart-ship direction. When the turning gear has been put out of operation, it is possible to move this central lever from its outboard or "stop" position either to the right or "ahead" position or to the left or "astern" position. The direction of rotation is clearly indicated to the operator by a pointer above the lever. Assuming the ahead direction to be the one chosen, then the movement of the lever to the right admits compressed air to the cylinder of the oil servo-motor, and at the same time exhausts the astern cylinder. This operates the ram and so moves the rack and pinion, which, by turning the fulcrum shaft, lifts the fuel valve and the

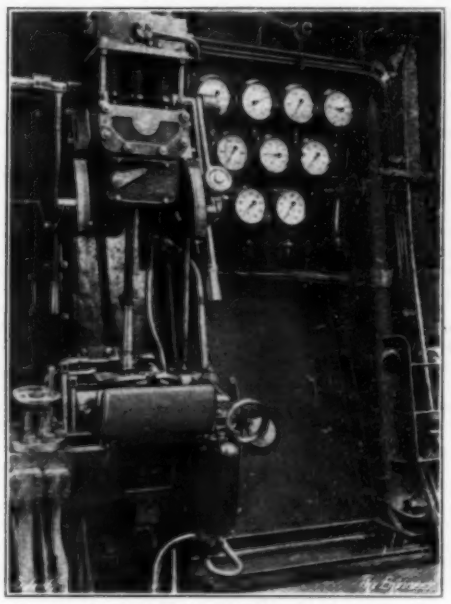


FIG. 4—STARTING AND RUNNING CONTROLS

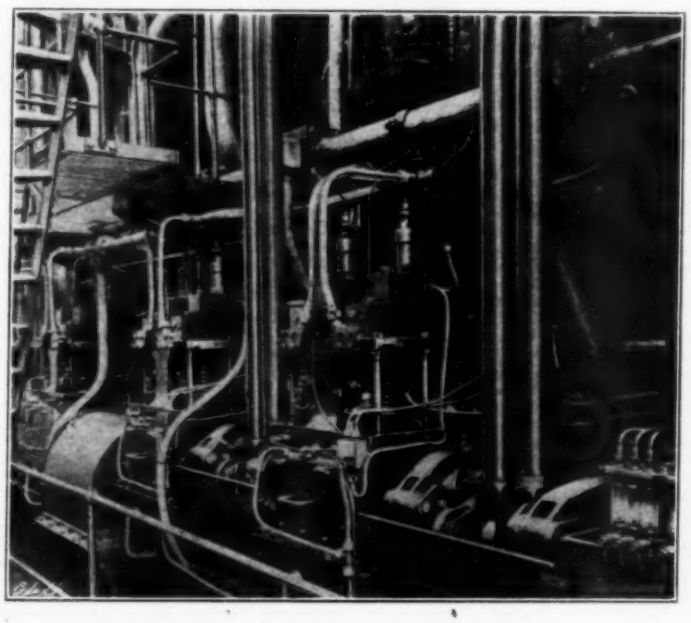


FIG. 2—CAMSHAFT AND FUEL PUMPS

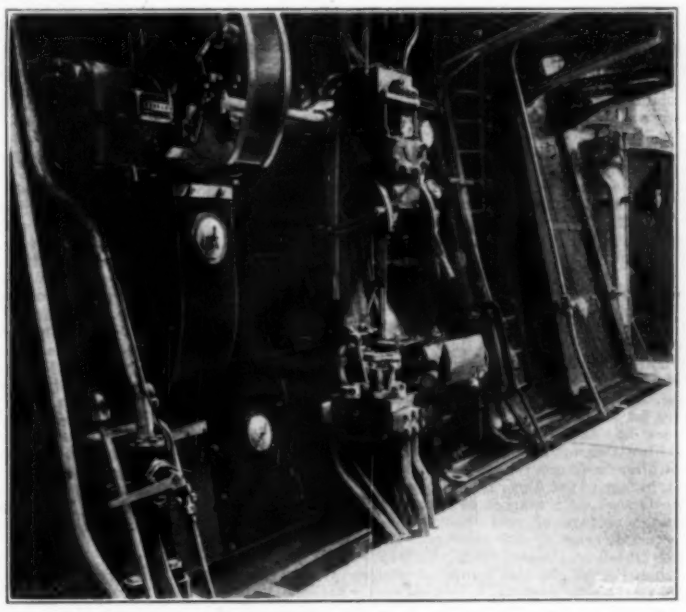


FIG. 3—STARTING PLATFORM

fuel pump levers from their cams, and after sliding the cam shaft longitudinally, replaces them in the operative position. By continuing the movement of the central lever in an inboard direction, the starting air valves on the cylinders are supplied, through master valves, with air from the reducing valves already referred to, and the engine then starts. When a few turns have been made the injection air and fuel are automatically supplied to the cylinder, and as the lever passes into the central running position the starting air supply is cut off. The speed of the engine can now be controlled by the fuel regulating lever to the right hand of the operator, while that on the left hand controls the air supply, and through the distributing valves arranged at either side of the centre starting lever plate enables the injection and starting air receivers to be charged up. To the right of the operator is a pressure gauge board. When the engine was running at 110 r.p.m., we noted that the injector air pressure was 1000 lb. per square inch, the first and second stages of the air compressor 24 lb. and 140 lb. respectively. The starting air pressure was 890 lb., and that in the injector air bottle 1020 lb. Readings of the gauges in the various oil and water services included 19 lb. for the forced lubrication pressure, about the same for the cooling water, with 24 lb. for the piston cooling water. The pressure of the scavenge air was indicated by a neat mercury-type gauge of the Budenberg Gauge Company's make and the reading was about 1·9 lb. per square inch.

The engine was afterwards run in our presence at the very slow speed of 33 revolutions per minute, and the firing at that speed seemed to be quite regular. The speed was then gradually increased to 121 r.p.m., at which speed the "Aspinall" emergency governor came into operation, checked the supply of fuel, so that the speed at once fell back to about 85 to 90 r.p.m. As often as the speed was increased, the governor came into operation, showing that the speed for which it was set could not be exceeded.

The engine we have described marks an important development in double-acting two-stroke practice, and the builders inform us that in the later designs of this same engine considerable simplification has been effected, which should enable both the size and weight of the engine to be materially reduced. It may be of interest to record that the weight of the engine we have described is 380 tons without the fly-wheel or turning gear. The design is one which sea experience has already shown to be suitable for ship propulsion up to the larger powers, and the builders point out that it offers as well a high power engine, which, utilising either air or airless injection, that can be effectively employed for both emergency and peak-load work in electricity supply undertakings.

The South German Coal Market.

THE sale of Ruhr coal for industrial purposes in South Germany has recently suffered a setback. It appears that the requirements of the textile industry, which has to face serious French-Alsatian and Czechoslovakian competition, are much smaller than hitherto. The metal industry, too, is using less coal than before. On the other hand, the tile works, at present fully employed, and the automobile industry are still good customers; while the chemical and paper industries are also working full time, and an increased demand for nut coal and coal briquettes for thrashing purposes has recently made itself felt. Generally, however, there is a reduced demand for coal, but it is to some extent helped out by the increasing requirements of undertakings ordinarily worked by water power, which, as in the case, too, of the larger electrical works, are forced to use coal at the present moment owing to the shortage of water. This water shortage has also led to a stabilisation of coal freights in the open freight market. Freights from Rotterdam to Mannheim inclusive of towing have risen recently from 1·30 guilden to 1·75 guilden. At present there is no traffic on the canal to Basle.

Holiday conditions also obtain in the house coal trade. British coal is being used in increasing quantities, being imported chiefly by South German municipal gasworks in Württemberg and Bavaria. This British gas coal is about 4 marks cheaper per ton c.i.f. than the same quality German coal. German coal prices have undergone no change since May 1st. The extent to which the Polish coal dumping policy has succeeded in driving out the Upper Silesian coal becomes evident when it is realised that Polish coal has already found its way to the Palatinate, and that, too, in face of the lower freights on Saar coal, which on its side is seeking a market in Bavaria. Thus there is the strange picture of coal trains from east to west and *vice versâ*, crossing one another. In addition to British coal, Dutch coal is also finding its way to South Germany, though British gas coal competes severely with it. In the last few weeks especially British coal has been largely bought, since the export premium of the British selling trust makes considerable savings possible. The new British subvention plans for coal freights should, too, have great effect on the sales of German coal, especially in the Scandinavian markets, and must greatly strengthen the position of the British coal industry in its quota demands in the case of the formation of any international syndicate or of a division of the markets.

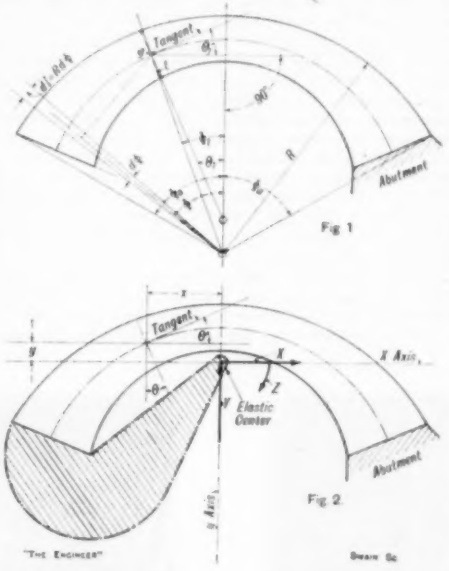
As regards the Saar coal market, few changes of any importance have taken place. The danger of a coal strike in the Saar, which was threatened for August 1st, was avoided, thanks to the good sense of the Saar miners. The result of the negotiations on the wages question in the Saar mining industry, which the Government Commission of the Saar territory carried on for several days at Paris, was that the wages increase demanded by the organisation was refused, but that the Government Commission decided, in view of the falling off in wages, which the miners employed in the Saar territory had suffered owing to holiday shifts, to pay them once for all the sum of 100f. on the third pay day in August. The Government Commission declared *inter alia* that a general increase of wages was impossible in view of the present state of the coal market, which did not permit of the mining industry bearing greater burdens, but that it was willing to negotiate further with the organisation if economic conditions in the mining industry showed a *de facto* improvement. The unions in view of present conditions in the Saar territory accepted these awards.

The coke trade, too, in South Germany is in a state of stagnation, since the summer rebate is no longer so great as hitherto. It stands for coke Mark I. and II. at only one mark, and for Mark III. at only 50 pfg. the ton. It should also be noted that this reduction is only valid for August. The lignite industry was recently so active that Rhenish lignite briquettes are sold out for the present. The position on the Upper Rhine is so satisfactory that even should the water fall still further, it will not affect deliveries. Since the Rhine shipping strike ended, canal traffic has considerably increased, as much ground had to be recovered.

As far as foreign coal is concerned, a further fall in the volume of water in the Rhine should mean relatively increased freights, so that, should that condition arise, the price of foreign coal may be expected to approximate more closely to the Ruhr coal prices.

Arch Dams with Rings of Variable Thickness.

IN an article with the title given above, by Mr. F. W. Hanna and Mr. T. L. E. Haug, published in *Western Construction News* of San Francisco, it is contended that "when a specific working stress has been assigned to the arch material and the arch is of such magnitude as to require thicknesses greater than a reasonable minimum to resist the loads within the specified working stress, arch rings of uniform thickness are not economical of material. Since the bending moment at the abutments is about double that at the crown, the total stresses due to moment and thrust are greatest at the abutments. A considerable saving of material can therefore be made by thickening the arch section towards the abutment and thinning it at the



crown." The authors furnish a method of arch analysis based on the theory of elastic displacements, the reasoning being similar to that in works such as Hool and Kinne's "Reinforced Concrete and Masonry Structures." The method of calculation may be understood from the figures herewith reproduced, which relate to a horizontal slice, 1ft. high, of an arch dam. In Fig. 1 the calculation relates to any point g on the vertical axis, the arch being first considered as being swung as a cantilever from the right abutment and acted upon by water pressure p producing total thrust $N_\circ$, moment $M_\circ$, and shear $V_\circ$ on the radial section at this point due to the load to the left thereof. On an elementary portion of the extrados to the left of g, such as $d\,l = R\,d\,\varphi$, the water pressure (*sic*) is $p\,R\,d\,\varphi$. Let φ_1 and θ_1 be positive for positions of g in the left-hand quadrant and negative for positions in the right-hand quadrant; the authors deduce :—

$$N_\circ = p\,R\,[\cos(\varphi_1 - \theta_1) - \cos(\varphi_a - \theta_1)],$$
$$M_\circ = -\,p\,R\left(R - \frac{t}{2}\right)[1 - \cos(\varphi_a - \varphi_1)],$$
$$V_\circ = -\,p\,R\,[\sin(\varphi_a - \theta_1) - \sin(\varphi_1 - \theta_1)].$$

Further reasoning is based on the condition of the arch conceived as in Fig. 2, in which the shaded area on the left is an imaginary bracket of infinite rigidity held in equilibrium at its left end by the thrust, moment, and shear normally taken by the abutment, and at the right end by three redundant forces X, Y, and Z, applied at the point O^1 taken as the centre of rectangular co-ordinates x and y, furnishing :—

$$N = N_\circ + X\cos\theta_1 + Y\sin\theta_1,$$
$$M = M_\circ - X\,y - Y\,x + Z,$$
$$V = V_\circ - X\sin\theta_1 + Y\cos\theta_1,$$
$$e = M \div N, \text{ excentricity of thrust.}$$

Expressions are also found for X, Y, and Z.

The method of design is to find the arch ring thickness approximately, by Cain's formula for a maximum allowable unit (*sic*) stress at the crown and apply the calculations for the increasing thicknesses towards the abutments. The method involves (1) drawing the ring to scale and dividing it into an even number of divisions, so that $d\,s \div I$, or $12\,d\,s \div t^3$ is constant, and locating the x axis so that $\Sigma\,y = o$ for all points g on the neutral axis at the longitudinal centre of the divisions. Centres angles and co-ordinates for the divisions are tabulated. (2) Computing and tabulating the values of $N_\circ$, $M_\circ$, $V_\circ$, X, Y, Z, N, M, V, and θ_1. Tension and compression are found by $f = \frac{N}{t} \pm \frac{6\,M}{t^2}$.

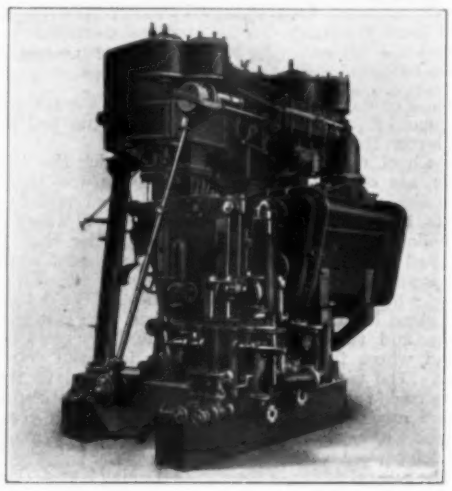
The article includes a study of temperature stresses. A short method of calculation for symmetrical arches in dams is also explained. A form for tabular records provides means by which complete formulæ for solving the arch ring may be developed.

Beardmore-Caprotti Marine Steam Engines.

IN recording the progress made in steam marine engineering during the year 1927 we referred in THE ENGINEER of January 6th last to some new triple-expansion engines which had been constructed at William Beardmore and Co.'s Coatbridge Works and were fitted with Beardmore-Caprotti valve gear. The first of these engines, shown in the accompanying engraving, was installed in a small steamer, the "Diamond." This ship went to sea early in the year and has recently completed with success her six months' guarantee period. We understand that the builders' claim for a 10 per cent. economy in coal compared with similar ships fitted with ordinary engines and operated under like load and speed conditions has been fully met.

The engine has cylinder bores of 13½in., 22in., and 37in., with a stroke of 26in., and at a working steam pressure of 200 lb. per square inch it is designed to develop 473 I.H.P. when running at a speed of 106 revolutions and a 35 per cent. cut-off.

The Beardmore-Caprotti gear is applied to each of



BEARDMORE-CAPROTTI MARINE STEAM ENGINE

the cylinders of the engine and separate double-beat drop valves are employed to control admission and exhaust. The valves are operated by cam gear, which is conveniently placed at the back of the cylinders and worked by a gear drive from the end of the main crank shaft. All the cams are enclosed in an oil-tight gear casing and run in an oil bath so that wear is negligible. This was confirmed, we understand, on examination of the engines after the period of service referred to. A special feature of the gear is that the cut-off can be varied through the complete range of powers both ahead and astern. The engine is controlled by a single hand wheel, which regulates the cut-off equally on all the cylinders. The stop valve remains full open all the time the engine is running, and maximum pressure is utilised. As will be seen from our illustration, both the admission and exhaust valves are grouped at the side of the cylinders. With this arrangement the usual length between cylinder centres, which is required to accommodate the ordinary type of valve gear, such as slide or piston valves, can be cut down. In the units we are describing the total length of the engine is only 10ft., whereas with the ordinary type of gear not less than 12ft. would, we understand, be required.

It was found that engines of the "Diamond" were easily handled and that they were particularly economical at reduced powers. Some slight modifications in the clearances on the poppet valve spindles and a reduction in the length of the spindle bearing were made just after the vessel entered service, and these improvements, which have since been embodied in the later engines, proved effectual in preventing the occasional sticking of valves which was experienced in the very early part of the guarantee period.

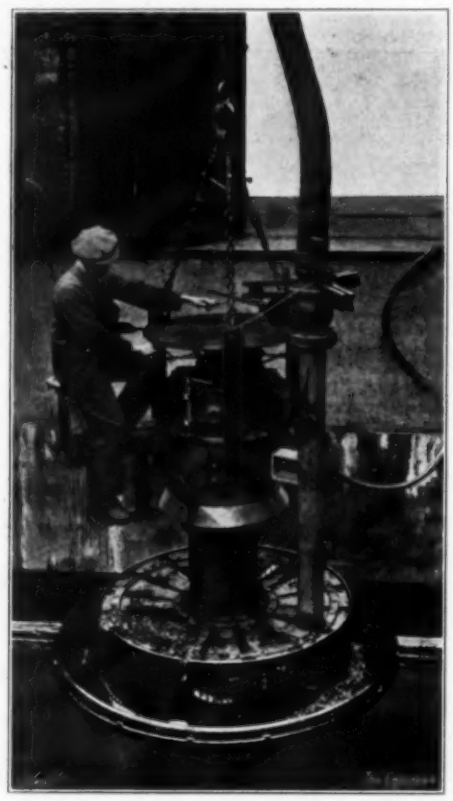
The second Beardmore-Caprotti engine was installed on the bulk oil-carrying steamer "Authority," which underwent successful official trials on the Clyde at the end of May last. The engine is generally similar in dimensions to that of the "Diamond," but the boiler pressure is 180 lb. per square inch and a 26in. vacuum is obtained in the condenser. During a six-hour fuel consumption trial a total of 4385 lb. of coal was burned, or 731 lb. per hour. The fuel employed had a gross calorific value of 12,377 B.Th.U. per pound, and the coal used per I.H.P. hour worked out at 1·77 lb., the average power developed during the six hours being 414 I.H.P. The makers regard the trials of the two first engines as confirmatory of the mechanical soundness of the valve gear and its thermal efficiency. In neither of the vessels we have referred to was superheat employed, but it is considered that with a

moderate degree of superheat Beardmore-Caprotti marine engines should be able to show a reduced fuel consumption of 20 per cent. compared with ordinary triple-expansion machinery. The application of the Beardmore-Caprotti valve gear to locomotive practice was described in THE ENGINEER of June 29th, and in that article some drawings of the poppet valves and gear mechanism were reproduced.

An Oil-skimming Pump.

ALTHOUGH there are now in existence a number of floating plants for the separation of the fuel oil from the water pumped out of ships' double bottoms and tanks, there are occasions when their employment is not convenient and the oily water is not infrequently allowed to escape into the dock, where it not only causes a local nuisance, but also, if the dock has to be pumped out, entails considerable labour if it is to be prevented from contaminating waterways. A scheme has, however, been evolved by Drysdale and Co., Ltd., of Bon-Accord Works, Yoker, Glasgow, which takes advantage of that characteristic of the oil which causes most of the trouble with ordinary methods of handling. The scheme involves the use of the special form of pump which we illustrate herewith.

Ordinarily, when a graving dock has to be pumped out and there is much oil floating on the surface of the water, pumping must be stopped before the dock is dry. Otherwise the pumps would suck up the oil and deliver it to the tideway, for it is impracticable to provide a separate pump discharge to deliver this oily mess ashore. So men are sent down into the dock to sweep and shovel up the oily



DRYSDALE OIL-SKIMMING PUMP

scum into crane buckets, and it is generally tipped on a dump, where the value of the oil is lost. In fact, it is an unsatisfactory process altogether.

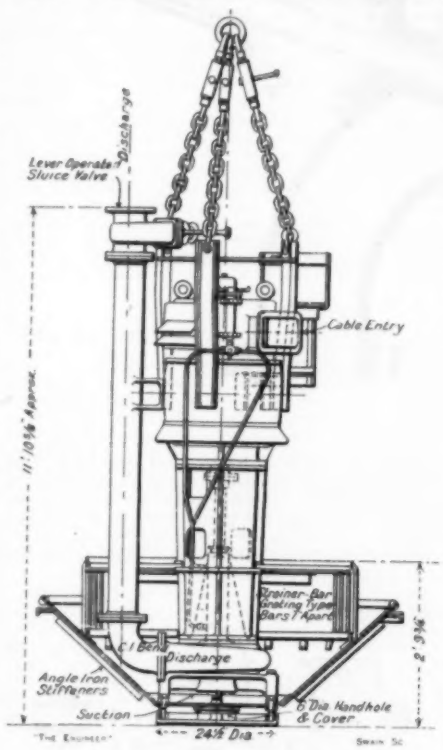
The Drysdale pump overcomes the trouble by skimming the oil off the surface of the water and discharging it through a separate delivery pipe. A small proportion of water must go through with the oil, but it is so small that the two can be readily separated in a settling tank. The oil can be recovered and the water is clean enough to run away to drain.

The secret of success of the scheme lies in the provision of a very shallow inlet to the pump, with a long perimeter, so that a thin film can be drawn off the surface of the water and yet a considerable quantity of liquid be handled.

On reference to the drawing it will be seen that a vertical spindle pump is used and that its inlet is arranged in the lower part of a conical saucer. This saucer is 6ft. 4in. in diameter and is of galvanised sheet steel, with a beaded edge which is machined to ensure that it lies in a true plane. There is an angle iron fender below and outside the edge to protect it from damage, while there is a heavy ring at the bottom to stand the whole machine on.

Within the saucer there is a full-way self-clearing centrifugal pump with its axial suction at the bottom. The suction is protected from floating *débris* by a bar screen running all round the saucer. The saucer is fixed to the main framing by only four bolts, so that it is a simple matter to remove it or to make a pipe connection with the pump suction for salvage purposes. The pump is capable of delivering 100 tons of oil and water per hour against a head of 70ft. and is driven by a 30 horse-power motor running at from 1000 to 1500 revolutions per minute. The discharge pipe is 5in. in diameter and terminates in a sluice valve at the top. The motor and pump are separated by a hollow cast iron distance piece and a ball thrust bearing is provided at the top to carry the weight of the moving parts. The whole machine is slung on three chains equipped with turnbuckles for adjusting it plumb and a seat is provided alongside the motor for an attendant.

A suitable position in the dock at which to operate the pump is selected, and flexible delivery piping is connected between the sling and the separating tank or barge on the ground level, or in the case of the latter outside the dock gates. The unit is slung plumb from a crane, started up with the discharge valve closed, and slowly lowered into the oil scum with the operator in place on his seat, until the upper edge of the tray is just below the surface of the water. The surface liquid will then start to flow into the tray, the oil being carried over on a very shallow film of water beneath it. The inherent surface tension of the oil causes it, when once in motion, to continue rapidly to flow towards the tray from all directions, and hence by the time the tray is filled a comparatively large area of the surface will have been skimmed. The discharge valve is



ARRANGEMENT OF OIL-SKIMMING PUMP

opened as soon as the tray has started to fill up, and closed again as soon as there is a break in the film of scum. The scum will then tend to close in again towards the part which has been cleared, and this can be expedited by hand in several ways until the unit is again surrounded by a further supply, when the procedure can be repeated.

Canadian Engineering News.

(From our own Correspondent.)

The Frood Nickel Mine.

IN preparation for the coming into production of the famous Frood mine in the Sudbury district of the Province of Ontario, the International Nickel Company is spending approximately 18,000,000 dollars. The programme includes the construction of a smelter with a daily capacity of 3000 tons; a 4500-ton concentrator, and the development of additional power. The company has already developed 21,000 horse-power at two sites on the Spanish River, and is about to install generating equipment at what is known as its Big Eddy barrage, which was built for the purpose of creating storage. With the completion of this undertaking an additional 18,000 horse-power or a total of 39,000 horse-power will be available. Part of the smelter feed will come from the 4500-ton concentrator. The total tonnage to be taken daily from the mines will probably aggregate 9000 tons. When the new plant is in operation International Nickel will be one of the world's foremost metal producers. It also promises to be Canada's largest silver producer. With the sinking of the big central shaft on the Frood completed to 3000ft., main drives are now being pushed out on three levels, and should reach the orebody in November. This shaft is the largest in Canada, and will have powerful equipment. The motor driving the hoist will be 3200 horse-power, and to get away from surge on the power current a 20ft. fly-wheel is being installed to help start the hoist. Ten-ton skips will be used. It is calculated that as much as 12,000 tons could be hoisted in a day.

The Riviere des Prairies Development.

The Montreal Light, Heat and Power Consolidated, which serves a section of the City of Montreal, and adjoining territory with electricity, is carrying out a huge power development scheme on the famous Rivière des Prairies, just north of Montreal, where it is proposed to generate 90,000 horse-power by utilising the energy in the swift currents of the river. The barrage, which is at present under construction, will ultimately have a length of two and a-half miles. The power-house will be 700ft. long, 100ft. wide and 75ft. high. Evenly spaced along this building will be ten generators.

Canadian Iron Ore.

Plans recently announced by the Algoma Steel Corporation, for a 12,000,000 dollar expansion of the steel plant at Sault Ste. Marie, Ontario, bring sharply into view the near approach of the mining of iron ore in the Province of Ontario. At present no iron ore is mined in Canada. There are vast quantities of iron north of Sault Ste. Marie, unlimited areas of magnetite in the Mississauga forest reserve on the Algoma Central Railway, and great hills of siderite in the Michipicoten area. At the company's New Helen Mine there are 20,000,000 tons exposed above grade—that is, the mining there will consist of simply blasting the side of the hill. In one deposit of magnetite in the reserve there are 150,000,000 tons above grade. The Algoma Steel Corporation spent 2,000,000 dollars in working out the problem of how best to deal with the low grade iron ore at the Magpie Mine, a small deposit, in Michipicoten some years ago. The Helen ore is exactly the same as that of the Magpie.

Proposed Central Terminus for Montreal.

Plans are being formulated for a large central terminus to meet the rapidly growing transportation demands of Greater Montreal and to serve, on a common basis, the purposes of the Canadian National and the Canadian Pacific Railways, the Montreal Tramways, the Montreal Harbour Commission, and the City of Montreal as a whole. The Federal Government is taking a keen interest in the proposed scheme, and has invited Mr. Frederick Palmer to make a preliminary survey of the situation. While no definite decision has, as yet, been reached, the scheme best favoured is the formation of a company representing all interests on the island of Montreal. It is held that such a joint concern, with a complete representation, would be the best guarantee for the protection and service to all the interests. The question of cost has also been considered, and a conservative estimate of a joint scheme to make provision for all the transportation demands would be 70,000,000 dollars. As to the position and scope of the joint terminus, a proposal now receiving favour is that both the Windsor-street terminus of the Canadian Pacific Railway and the tunnel terminus of the Canadian National Railway should be utilised.

B.E.S.A. SPECIFICATIONS.

AUTOMOBILE PARTS.

THE following new British Standards have just been issued:—No. 5021, 1928, British Standard Dimensions for Unions, Nipples, and Nuts (B.S.F. and B.S.P.) for Automobiles, and Nos. 5037–8, 1928, British Standard Dimensions for Centres for Artillery Wheels, Centres for Steel Disc Wheels, Hub Flanges for Steel Disc Wheels for Automobiles.

The dimensions dealt with in these specifications were originally prepared and issued by the Society of Motor Manufacturers and Traders as S.M.M. & T. Provisional Standards, Nos. 22, No. 5 R, and No. 40, and having been submitted to the British Engineering Standards Association with a request that they should be made into British Standards, have now been issued by the Association.

In No. 5021, 1928, two series of unions are included, one with B.S.F. threads and one with B.S.P., to be distinguished by the letters "F" and "G" respectively, stamped on the face of the hexagon. It is recommended that B.S.F. fittings be adopted in future designs where possible. The thread sizes for the unions are from $\frac{3}{8}$in. to $1\frac{1}{4}$in. B.S.F. and from $\frac{1}{4}$in. to 1in. B.S.P.; these two ranges should cover all reasonable automobile requirements.

In No. 5037–8, 1928, the Standards, which are issued in one volume, provide for the interchangeability of wheels in relation to the hub flanges. For artillery wheels, a five-stud type is specified, and for steel disc wheels four, six, seven, and ten stud types are provided to meet the varied requirements. It is hoped that the chassis makers will adhere as far as possible to these types in order to simplify and cheapen production.

Copies of these specifications may be obtained from the Publications Department, B.E.S.A., 28, Victoria-street, Westminster, S.W. 1, price 2s. 2d. each post free.

AMERICAN TEN-COUPLED GOODS ENGINES.

THE coal trains on the Chicago, Burlington and Quincy Railroad have been increased from ninety-seven cars, of about 6800 gross tons, to a hundred and thirteen cars, or 8000 gross tons, by new ten-coupled engines having the four-wheel type of trailing bogie. These engines are of the 2–10–4 class and may be equipped later with boosters on the trailing bogies. The tractive force is 90,000 lb., as compared with 81,600 lb. for the engines formerly used, while the coal consumption is 16 per cent. less, the water consumption 22 per cent. less and the time of run about 25 per cent. less. The main particulars are as follows:—

Cylinders	31in. by 32in.
Valves, piston, diameter	1ft. 3in.
Valve gear	Baker radial
Wheels, driving	5ft. 4in.
Wheels, leading bogie	2ft. 9in.
Wheels, trailing bogie	3ft. 6¼in.
Wheels, tender	3ft.
Wheel base, driving	22ft. 4in.
Wheel base, engine	45ft. 6in.
Wheel base, engine and tender	96ft.
Weight on drivers	175 tons
Weight on leading bogie	23 tons
Weight on trailing bogie	53 tons
Weight of engine	251 tons
Weight of engine and tender	440 tons
Journals, driving	14in. by 14in. and 12in. by 14in.
Boiler, diameter	7ft. 8in.
Fire-box	12¼ft. by 8¼ft.
Tubes	2¼in. and 3½in.
Length of tubes	21ft. 6in.
Heating surface, all tubes	5455 square feet
Heating surface, fire-box	302 square feet
Heating surface, combustion chamber	107 square feet
Heating surface, fire-box arch tubes	40 square feet
Heating surface, total	5904 square feet
Superheating surface	2487 square feet
Boiler pressure	250 lb.
Water in tender	21,500 gallons
Coal in tender	24 gross tons

The Speed Control of Impulse Turbines.

The problem of accurately governing the speed of water turbines of the Pelton type is a fundamentally different one from that of governing a steam turbine, steam engine, or an internal combustion engine. Controlling devices used in the past included deflecting nozzles; by-passes of the same area as the nozzle, which opened as the latter closed; diffusing blades placed within the nozzle itself, and governing by "flaring" the jet. The most common device at present in use is the "Slipper" deflector, shown in dotted outline in the sectional view of a needle

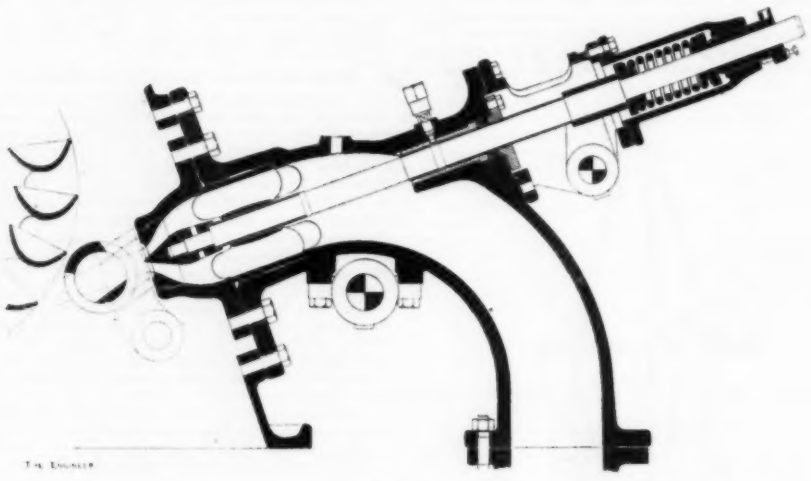


FIG. 1

in Fig. 1. This view also compares the old deflector with the improved deflector which has been produced by Mr. Percy Pitman, of 25, Victoria-street, London, S.W. 1.

The improved device, which is an adaptation of the one illustrated in The Engineer of February 12th, 1926, consists of a tubular deflector working on ball or roller trunnion bearings which are placed coaxially with the nozzle—see Fig. 2. When the turbine is running on full load the jet passes centrally through the bore of the deflector as shown in Fig. 1. If the whole load is suddenly thrown off the turbine the jet is split by the two edges and is momentarily diverted from the wheel buckets, as shown diagrammatically in Fig. 2. Both the internal and lower external portions of the deflector are radial, and the very slight forces exerted are practically equal and balanced, enabling the deflector to be operated with ease and rapidity.

If economy of water is not a consideration, the shaft governor may be directly connected to the deflector. For direct connection to electric generators the governor weights F, Fig. 3, are made extremely light and are supported against the tension of a spring by means of the steel plate springs A A, the whole action of the governor being based on elastic shape alterations. The movement can be transmitted to the deflector either by a form of bell-crank lever or by suitable linkwork. This arrangement of deflector operated directly from the governor pendulum has been successfully applied to units up to 200 B.H.P.

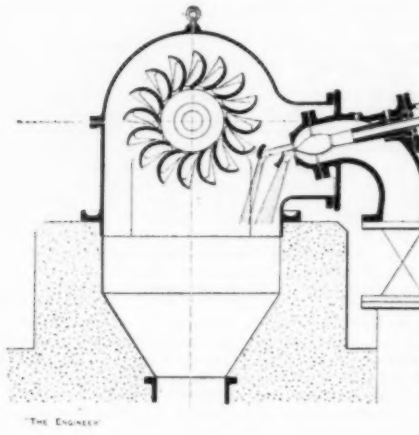


FIG. 2

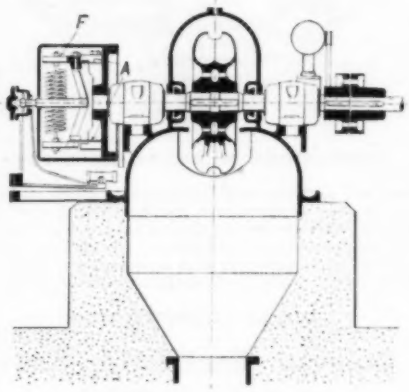


FIG. 3

Figs. 4 and 5 show diagrammatical views of the Pitman deflector when used in combination with any standard oil pressure governor. The deflecting of the jet is followed by the slow closing of the automatic needle to effect the necessary economy of water. The rate of movement of the needle is regulated by an adjustable valve on the dashpot, thus controlling the pressure rise in the pipe line. With gradual changes of load the deflector and needle are operated simultaneously. The movements of the needle and deflector are definitely related to each other, and both are dependent on the position assumed by a single governor. It is impossible for the deflector to foul the needle under any conditions of working. It should be noted that a short or "stub" type of needle is used. It has been found entirely satisfactory, and it produces a solid jet with entire absence of flaring.

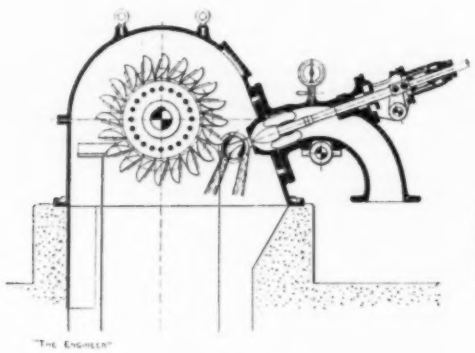


FIG. 4

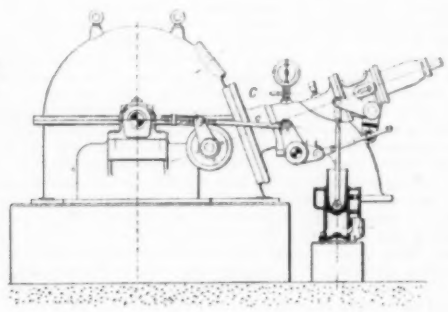


FIG. 5

To prevent the turbine running away in the event of the governor belt breaking, an auxiliary shaft governor can be fitted. It operates as follows:—If the speed of the turbine increases to 20 per cent. above normal, a catch is released and the whole of the water is deflected from the buckets, thus stopping the turbine. The spring on the end of the rod C, Fig. 5, enables the deflector to be operated by the emergency governor, and so stop the turbine without changing the position of the servo-motor.

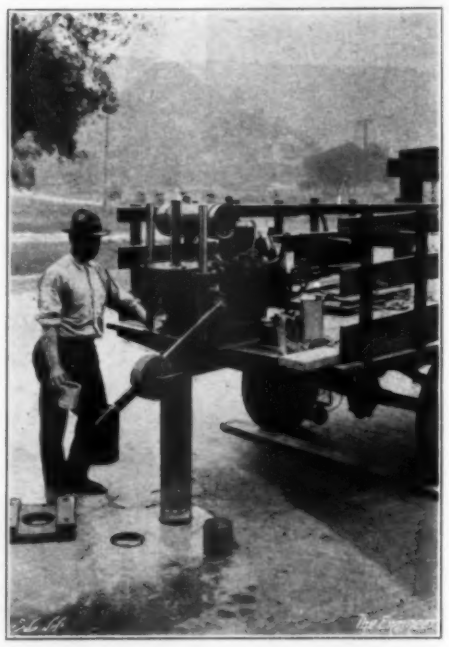
We have to thank Theodore Bell and Co., Kriens, Lucern, Switzerland, who are interested in the Swiss patent rights for this method of governing and have made exhaustive experiments with it, for the drawings reproduced herewith.

Pavement-Testing Core Drill.

A self-contained core drill for testing the nature of concrete road beds has recently been put upon the market by the Sullivan Machinery Company, of Salisbury House, E.C. 2. It is shown in the accompanying illustration. The machine is designed to drill a 6¼in. hole and to remove a 6in. core at the rate of 1ft. in depth in from 15 to 20 minutes, and we are informed that a 7in. carpet has been penetrated in 9 minutes. With the core barrel that is usually fitted the machine will drill to a depth of 18in.

The drill comprises a drive rod which is rotated through bronze worm gears by a direct-connected petrol engine. This drive rod is kept in alignment by sturdy side rods, which are connected to a crosshead at the bottom of the drive rod, and which pass through cylindrical sleeves that are cast in one piece with the bedplate or frame supporting the drill and the engine. At the lower end of the drive rod is a spider to which the core barrel is bolted. The drill is fed downwards, automatically, by means of a double rack cut on the side rods, and double pinions. The drilling speed is controlled by a hand lever, which is weighted, the weight being shifted along the lever as desired, so as to secure the requisite pressure on the core barrel for drilling. The crosshead is equipped with a ball bearing to take both the radial and thrust loads and to provide a rigid support for the barrel.

The gears at the top of the drive rod mesh with driving gear on the end of the shaft of a Buda 6 horse-power, two-cylinder, opposed type, air-cooled engine, and the gears, which are totally enclosed, run in a bath of oil.



PAVEMENT-TESTING CORE DRILL

In operation, the equipment is mounted at the rear of, say, a motor truck, as seen in our illustration. In starting a hole, a guide plank, in which a hole just large enough to allow the passage through it of the core barrel, is laid on the pavement to be sampled, and the operator stands on the board. As the barrel passes through the hole in the board it is held firmly for starting the hole in the concrete. A small handful of shot and a pint of water is poured into the core barrel, which is open at the top. The engine is then started. From time to time more shot and more water are added, though it is stated that but little shot is required. The shot find their way into two vertical slots cut in the bottom of the core barrel, and roll, from them, under the face of the barrel. As they do so, the pressure brought to bear on the barrel by the weighted lever crushes the concrete beneath them. The water serves to wash out the ground material and to keep the barrel from wearing away too quickly. The speed of rotation recommended is about 100 revolutions per minute.

The overall measurements of the machine, which weighs 772 lb., are length 31in., height 44in., and width 29in.

Despite the dense traffic on the subway system in New York City, there has been a remarkable freedom from fatal accidents. That splendid record was, however, broken on the late afternoon of Friday, August 24th, when a passenger train was derailed in Times-square Station. At the rush-hour passengers are quite indifferent as to where and how they ride, and the platforms at the ends of the cars are, in particular, crowded. It is not, therefore, surprising to hear that, as telescoping followed the derailment, many passengers were killed. It is said that the train was permitted to travel over a set of points which were known to be out of order. It may interest some of our readers to know that the Inter-State Commerce Commission has no control over this system. It is intra-state line, *i.e.*, wholly within the State of New York, so, not being inter-state, the Commission has no control.

South African Engineering Notes.

Railway Development.

An interesting programme of work to be carried out throughout the country is outlined by the general manager of the South African Railways in his last bulletin. He points out that £275,000 are to be spent on development at Germiston workshops, and £117,000 at Pretoria workshops. He refers to the quadrupling of the line between George Goch and Doornfontein, and the doubling of the line between Pretoria and Hercules. For the current year an expenditure of £1,567,000 has been voted for new rolling stock. Under this head provision is made for the purchase of 174 steam locomotives. He points out that in consequence of the amount to be spent on signals, the installation throughout the Union railways will be greatly improved and modernised; while by the extension of the selector telephone system traffic will be better handled.

The general manager also alludes to the fact that the amount voted as a charge to loan and betterment funds for the year is £6,350,000, which includes, among other items, the following:—£1,278,631 for new lines of railways; £2,270,930 for new works on existing lines; £1,624,876 for rolling stock; £630,305 for harbours; and £225,158 for working capital. In addition to the £6,850,000 referred to, it is estimated that £2,314,108 will be expended during the year from the renewals fund on various works and rolling stock. The gross estimated outlay for the year from all sources, including a small amount chargeable to working costs, is £8,667,551.

There is provision for £147,277 for the three short railways included in the 1927 construction programme. Among these is the Messina-Limpopo River line. This line will be extended for a distance of about a mile on the Rhodesia side of the river, and will be constructed by the Administration at the expense of the Rhodesian Government. A noteworthy feature of this extension is that the combined road and rail bridge which will span the Limpopo River is to be the gift of the Beit trustees to the Union and Rhodesia Governments. The bridge is to be named the "Alfred Beit Bridge," and will be designed and erected by the trustees' consulting engineers in collaboration with the Administration.

The programme of additions and improvements to the permanent way, including new crossing stations, yard extensions, and additional tracks is estimated to cost £1,058,158, of which amount £243,000 has already been expended, while for the current year provision has been made for an expenditure of £350,000. Spread over the nine systems of the Union Railways, schemes at present in hand or contemplated for relaying and strengthening the permanent way are estimated to cost £4,622,000. Of this sum £1,514,000 had been expended at March 31st last, while £2,000,000 is provided to meet the current year's expenditure. Regrading and deviating lines with a view to facilitating the train haulage continue to receive attention as the availability of funds permits, and the present programme under this head is estimated to cost £561,000. Of this amount over £140,000 had been spent at the end of the last financial year, while £121,000 is set down to cover this year's expenditure.

Among the improvements projected in the telegraph and telephone systems perhaps the most noteworthy is the extension of the selector telephone system. This method of telephonic communication is of the greatest importance in the control and distribution of rolling stock, the efficient disposition of which so largely contributes to the economical and satisfactory working of traffic. Included in the programme already mentioned under this head is a sum of £195,723 for installing and extending selector telephones at all system headquarters, of which amount £53,000 has been provided to meet this year's expenditure.

The total cost of the programme for new station buildings, goods sheds, quarters and fixtures of various kinds, as well as improvements, alterations and extensions, is estimated at £1,609,000. Of this sum £363,000 has already been expended, and £582,000 is available for the current year; £150,000 has been provided for in this year's estimates for work in connection with the new station at Johannesburg.

Workshop extensions and improvements are the natural corollary of the development of engine power and the general increase in traffic. The Workshops Commission of 1925 made many recommendations for dealing with rolling stock repairs, the enlargement of workshops, and increase of equipment. The programme now being carried out over a period of several years totals £1,228,000, of which £210,000 has been expended, £468,000 being provided for the current year. The following are amongst the most important items:—Bloemfontein workshops, estimated cost of scheme, £275,000; Germiston workshops and wagon yard, £275,000; Pretoria workshops, £117,000; Salt River workshops, £194,000; new machinery—all systems, £325,000. In addition to new rolling stock, £470,000 is allocated to alterations and improvements to existing stock. Of this sum, £184,000 had been spent up to March 31st last, and £202,000 is provided to cover the cost of this year's work.

New Mineral Belt in the Congo.

A new mineral field of great promise is being opened up in the Eastern Congo. The mineralised belt in question extends along the western side of Lake Tanganyika and into the mandatory territories of Ruanda-Urundi, ceded to Belgium from Tanganyika Territory. Large areas containing gold, tin and copper have been acquired, and fourteen trained geologists and mining engineers are now in the field investigating the extent and value of the occurrence, and initiating a preliminary development policy. During the past year or two, important tin fields have been discovered along the Uganda–Congo–Tanganyika borders, and the existence of copper ores has also been determined. The Tanganyika Concessions Company is dispatching an expedition to the Ruweuzori range—the famous "Mountains of the Moon"—to examine copper deposits which are reported to exist there at high altitudes. Various other expeditions are busily engaged in prospecting this portion of Africa for mineral wealth, and the indications are that in the near future several important mines will be opened up along a line of mineralisation which has a north and south line of strike, and which appears to traverse a considerable portion of Central Africa in the region of the Great Lakes. In so far as the developments in the Belgium Congo are concerned, the company which, in the main, is sponsoring these mineral developments, is the Crédit Général du Congo, which is backed by the Banque de Bruxelles.

The Crédit Général, together with three other companies, secured prospecting rights over 1,000,000 hectares, and each of these concerns had the right to demarcate 50,000 hectares by the middle of June. The four areas, each of 50,000 hectares, were demarcated by June 10th, and plans for the systematic exploration of the whole large area secured—200,000 hectares—are now being completed. A concern styled the Syndicat Africain Minière has been formed to deal with these properties. Copper deposits containing amongst other ores chalcocite with a very high copper content, have been discovered, and also cassiterite and gold. Some of these mineralised zones occur in close vicinity to Lake Tanganyika, and in these instances the transportation problem should be comparatively simple and freight charges low, as the steamers on the Lake have a port at Kigoma, which gives direct access to the Indian Ocean at Dar-es-Salaam over the Central Railway line in Tanganyika Territory. The big groups concerned with this new phase of mineral development in the Congo appear to have conducted their operations with great secrecy, and up to the present little information has been given out. It appears, however, that the discoveries made to date are of great potential importance, and that much more will be heard of the new mineral belt in the near future.

State Steel Industry.

The Government has now appointed the board of directors for the South African Iron and Steel Industry Corporation, which was sanctioned by Parliament recently, will be under Government control, and to some extent financed by Government. The Government experienced great difficulty in forming the board, and numbers of eminent men were approached in vain; but the board has now been constituted, and its *personnel* is as follows:—Dr. H. J. van der Byl, Chairman of the Electricity Supply Commission. He is a Pretoria man, and was educated at Victoria College, Stellenbosch, and at the Universities of Halle, Leipzig, and Chicago. Mr. C. F. Delfos, an engineer who has been closely associated for years with the iron ore deposits at Pretoria, where the works will be situated, and has repeatedly sought financial support for the undertaking overseas without success. These two will each receive £2000 per annum, being permanently appointed. Dr. A. J. Bruwer, the youngest member of the board, is Chairman of the Board of Trade and Industries. He is also a product of Stellenbosch and America. He took a degree in America in public finance, and is an economist, at least that claim is advanced for him. The last member of the board is Dr. J. H. Dobson, D.S.O. He is fifty years of age and was born at Crewe. Educated at Crewe, Manchester, and Liverpool, he is a director of Dowson and Dobson, Ltd., engineers, &c., and was formerly Professor of Electrical Engineering at the South African School of Mines and Technology, and was general manager of the gas and electric supply and tramways, Johannesburg, during 1908–19. He and Dr. Bruwer are only appointed for one year, and their salaries are, it is announced, to be £600 each.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Situation Unchanged.

There has been no change in the industrial situation in the Midlands and Staffordshire during the past week. The staple industries show little variation, and this position is likely to continue for another week or so. The slight improvement in the iron and steel trades reported in my last letter is maintained, though it has not been materially added to. Some branches of the industry are doing better, but others appear to make little headway against adverse conditions. Inquiries continue to increase in number and tonnage, and some members of the Exchange this week claim to perceive signs that the autumn will see the placing of business on a heavier scale. It is much to be desired, and is earnestly hoped for.

Steel.

Although there is no very perceptible increase in demand for finished steel and half-products, producers continue hopeful. The steel works in this district are moderately busy, and the plate mills of the Black Country are fairly engaged on steel wagon work. A number of orders for boiler plates have recently been given out in connection with renovation and plant equipment generally. Angles and joists sell slowly, as do hoops. Midland steel masters, in common with those in other parts of the Kingdom, are holding their own in many branches against foreign competition. Makers of small bars now regard £7 7s. 6d. as the irreducible minimum. Many of them this week did business at £7 10s. Welsh billets which sell at £6 2s. 6d. for 2in. hold the market. The only chance which the foreigner has is on the larger sizes. Continental prices are a shade firmer in some lines, but on the whole the market is substantially the same. Plates of ¼in. thick, which have been on the same level for some time, have been advanced 2s. Billets are rather easier, and blooms are up by 2s. 6d. Foreign corrugated sheets, which have kept stationary for the last month, are up by 1s. 6d., and sheet bars by a similar amount. These changes, however, are so trifling as to leave the market unaffected. English wire rods are offered at £8 10s., leaving only a margin of about 10s. in favour of the purchaser of continental material. The wire rope trade is not taking very much material at present. Special steels are in fair request for tool making, but orders have fallen away somewhat as the motor car season approaches its end. Steel scrap is firm at £3 7s. 6d. delivered South Wales.

Raw Iron.

There is very little evidence of any expansion of demand in the pig iron department. Some Midland smelters on 'Change in Birmingham to-day stated that they are being asked to accelerate deliveries of pig iron against contracts, but very little was heard of commitments being materially augmented. Blast-furnacemen, while consoling themselves with the fact that prices have reached the minimum, are optimistically basing their expectations of a stronger market in the near future on the assumption that stocks of raw material in the hands of foundrymen are insignificant. Even the most hopeful, however, can discern no prospect of betterment in the forge branch of the industry. Small tonnages of foundry material changed hands this week. Derbyshire material ranged in price from £2 19s. to £3, and Northamptonshire from £2 15s. to £2 16s. Some inquiry is about for East Coast hematite, delivered in Birmingham at £4 3s. to £4 4s. 6d., and West Coast at £4 5s. Makers of cold blast iron find a very fair market for the casting of heavy roll machinery.

Staffordshire Iron.

There is no change to record in the Staffordshire finished iron industry on the week. The mills are moderately employed, and while makers of high-grade bars are still able to get in a full week's work, their reserve of orders is becoming small. Values are upheld at £12 per ton. In the Crown bar department conditions remain as for some time past. The disparity in quotations and the keen competition show no sign of easing, so that few orders come to the Staffordshire makers, whose prices are higher than those of their competitors. It is only when quality is imperative that the business is given to local ironmasters. The slight improvement in the common bar branch continues. No. 3 Belgian iron, which at one time was bought in large quantities by nut and bolt makers, has lost much of its attraction by the steady increase in the price, and most of the mills making nut and bolt iron locally have booked orders. The ruling price is £8 15s., but occasionally business is done at slightly higher figures. Tube mills are taking larger quantities of gas strip, and prospects are better for the coming months. Sales are made at £10 15s. upwards.

Galvanised Sheets.

There is a moderate amount of employment at the galvanised sheet mills, but all of them could do with more work. The export demand is still unsatisfactory, orders being extremely irregular. Prices are steady, 24 gauge corrugated sheets being £13 7s. 6d. to £13 10s., the latter price being paid by domestic consumers at home. Manufacturers report that they have experienced a moderately good season, taken all round, so far as the home market is concerned. The overseas call for thinner gauges is steady and values are maintained. The extras now demanded are £1 15s. for 26 gauge, £2 5s. for 28 and £2 15s. for 29. As previously stated, there is now a free market in 30 gauge, and the ruling price is £17 5s., a fall of 10s. as compared with the controlled price.

New Stourport Factory.

A large factory for the manufacture of electrical porcelain is to be erected at Stourport. Foundation work has commenced. It is stated that British plant and equipment will be utilised in the new factory as far as possible, but it is thought that the grinding mills may have to be brought from Germany, because their cost would be about one-third that of British mills. From an engineering point of view an interesting feature of the equipment of the factory will be a special high-tension battery station, which, it is stated, will be equipped with apparatus for testing up to 1,000,000 volts.

Rolling Stock.

The Midland railway carriage and wagon constructing establishments are reasonably busy, and continue to hold their own in the fight for orders. While attention has been focussed on the large order for all-steel wagons recently placed with the Metropolitan Carriage, Waggon and Finance Company, other builders of rolling stock in the Birmingham district have been booking some useful contracts. Amongst these, the Birmingham Railway Carriage and Waggon Company, Ltd., has taken a series of wagon-lit contracts, chiefly for the Argentine, forty for a French company, thirty-two all-steel second-class coaches, forty-six first-class and fourteen composite for Egypt. Usually the prices are finely cut, owing to severe competition with the Continent. Another South African order for all-steel wagons is known to be pending, and will probably be secured by one of the Birmingham builders. The Midland Railway Carriage and Waggon Company is also understood to be busy, especially on repair work.

Warwickshire Miners' Wages.

Notices have been posted at what are known as the "B" grade pits in the Warwickshire coalfields, terminating all agreements with all persons engaged under the existing wage agreement. The pits concerned are Pooley Hall, Newdigate, Keresley, Exhall, Binley, and Tamworth, employing nearly 3000 men. The object of posting the notices is to give the owners of the pits in question an opportunity of applying for a reduction of wages, as they find themselves unable to pay the same minimum as the richer pits. The matter has been in hand for some time, and representatives of the Miners' Association have met the owners of the collieries at various times to see if they could find a way out of the trouble without bringing about a possible reduction in wages and breaking away from the county agreement. The "B" grade collieries have, however, found themselves in such a bad financial position that they have been compelled to take the above-named step. The trouble is due to natural economic causes.

Every method that could be thought of has been discussed with a view to tiding over the trouble till more prosperous times arrived, but without success. A meeting of the Joint Wages Board of the Warwickshire coalfield has been called for this week to consider the position and the attitude to be taken with regard to it.

LATER.

At the meeting this week of the District Joint Wages Board held to consider the position which has arisen in the Warwickshire coalfield, as already reported, the Board agreed to such a variation in the terms of the wages agreement as would admit of an alteration in the minimum percentage payable under the agreement, and invited each colliery, at which notices had been posted, to bring its case before the Board for consideration and decision. The decision arrived at signifies a recognition on the part of the men of the difficult conditions existing in these particular collieries. The hope is expressed that judgment will lead to the situation being clarified.

Cannock Chase Matters.

The Cannock Chase coalowners have had another unfortunate month. In July there was an average loss per ton on coal raised of 1s. 9·47d., against 2s. 1·47d. in June, and 1s. 1·65d. in May. The owners' accumulated deficit now stands at £2,178,520, an increase of £177,410 on the month. Miners' wages for September will remain at the minimum of 42 per cent. on the basis rates for the fifteenth consecutive month. The minimum wage of stallmen will continue to be 9s. 4d. per shift; loaders, 8s. 4d.; and surface workers, 6s. 8d.

Unemployment.

The unemployment returns for the Midlands area have this week taken a turn for the better, a reduction of over 5000 in the number of persons out of work in the area on the week being recorded. The total now stands at 212,020, to which the Birmingham area contributes 133,545, Coventry 8304, Stoke-on-Trent area 24,732, and Wolverhampton 7208. There has been a general decline in the figures in the Black Country towns, Smethwick and Walsall proving the exceptions.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Lifting a Bridge.

AN interesting engineering operation in connection with one of the bridges spanning the Manchester Ship Canal is being carried out by Sir William Arrol and Co. The bridge structure in question is the Old Trafford swing bridge, a huge affair measuring 211ft. long, 60ft. wide, and 30ft. deep, and weighing 1800 tons. The bridge, which carries the traffic of one of the busiest thoroughfares in Manchester or Salford, was completed in 1894, and was opened to traffic simultaneously with the opening of the Ship Canal in the same year. Its purpose is to permit shipping to pass up the canal to Pomona Dock. It has been found necessary to replace the cast iron rollers—sixty-four in number—which operate in the turntable of the bridge, and, at the same time, to overhaul the machinery. New rollers of hardened steel are to be substituted, and to enable that to be done the bridge is to be lifted bodily to the extent of about 6in. Messrs. Arrol have been busy for some time on the construction of a temporary staging to support the weight of the bridge whilst the rollers are being fitted, and this preliminary work is not expected to be completed for another month or so. The total cost of the work is in the neighbourhood of £40,000.

The End of an Electricity Scheme.

Following the withdrawal of the Altrincham Council from the petition presented by a number of joint authorities in North Cheshire to the Electricity Commissioners for a special order to purchase the undertaking of the Altrincham Electric Supply Company, Ltd., the Joint Committee has decided not to proceed further with the matter.

Non-ferrous Metals.

Tin is the only section of the non-ferrous metals to lose ground compared with a week ago, copper, lead and spelter all being fractionally higher on balance than at last report. The demand for tin just now is relatively light, and that factor, combined with scanty speculative buying of the metal and continued uncertainty regarding the immediate outlook, has reacted on prices. The loss on the week has varied between £1 and £2 a ton, according to position, and values seem to be gradually drifting back to the low point touched early in July. Before that is reached, however, there may be a change in market sentiment, for in some quarters there are expectations of an expanded consumption in the near future. Until signs of this expansion mature continued easiness is not improbable. On balance, copper is dearer to the extent of several shillings than it was a week ago, in spite of the fact that buying interest in the metal, so far as standard brands are concerned, has latterly been on quiet lines. Statistically, the outlook would seem to favour a period of steady prices, with occasional lapses, such as has been experienced during the past few months. Fair purchases of the metal have been made by British cable manufacturers. Sales of lead has continued on a comparatively satisfactory scale, and prices have further hardened under the additional stimulus of talk of output control. There has been no more than a quiet demand for spelter, and values gave way in consequence, although the loss has been more than recovered since.

Iron.

Pig iron users in this part of the country seem, for the most part, content to buy sufficient of the raw material to cover their early requirements, only the most favourably situated foundries venturing ahead to any important extent. Comparatively few additions have been made on this market to the contract bookings reported recently, and conditions this week have been undoubtedly slow, individual orders being confined to small tonnages. Without going so far as to anticipate any material expansion in the demand for the metal, sellers are quietly hopeful, now that the holiday season is approaching its end, of some improvement in conditions during September. Prices have not weakened further to any appreciable extent, but they are anything but strong. Quotations for delivery in the Manchester area of Staffordshire and Derbyshire brands range from 67s. to 67s. 6d. per ton, with North-East Coast iron fully maintained at 79s., delivered Lancashire. Except in a few instances where, owing to shortage of supplies through curtailment of output, makers are asking up to 90s. per ton, delivered, Scottish iron is obtainable at about 87s. 6d. Hematite iron meets with a poor demand, but there has been little change in prices, these ranging from 81s. 6d. to 82s. per ton.

Steel.

A number of the steel-rolling mills which compete in this market were closed last week for their annual holidays, and on the resumption this week reported, in several instances, an unsatisfactory flow of specifications. Quotations keep steady all round, however, with 3in. bars at £8 17s. 6d. per ton, small re-rolled bars at £7 15s., frame and general plates at £8 12s. 6d. to £8 17s. 6d., joists at £7 17s. 6d., acid boiler-plates at £9 17s. 6d., and basic qualities at £9 12s. 6d. Continental semi-finished steels are practically unobtainable, with French and Belgian producers out of the market and German works offering very small quantities. Finished products are in poor request on this market, but prices are distinctly firm and dearer than a week ago. Because of the scarcity billets and sheet bars are more or less nominal at £5 13s. to £5 15s. per ton for cash against documents, and including delivery to Lancashire works, with wire rods firmer at £6 17s. 6d. per ton, angles at £6 17s. 6d., joists at £6 2s. 6d. to £6 5s., steel bars at £7 2s. 6d., Siemens plates at £8 3s. 6d., and bar iron at about £7 per ton.

BARROW-IN-FURNESS.

Hematite.

There is nothing fresh to report in the pig iron market, which still remains quiet. There are as yet no definite signs of the revival which is expected, and buyers are still content to place orders just for their immediate requirements. The fact that the steel works are still engaged accounts for a substantial local demand for iron. Overseas trade is quiet. There is moderate activity in the iron ore trade, but outside business is not large at present, and as for local demands they are steady but not very heavy. The steel trade is quiet and fresh orders are required if the mills are to be kept running for an appreciable period. The hoop mills are better situated.

SHEFFIELD.

(From our own Correspondent.)

Steel Market Quiet.

CONDITIONS in the iron and steel trades during the past week or two have been worse than any experienced for a considerable time past. From all departments come complaints of shortage of work, and the fact that of the ninety furnaces in the Sheffield area, only thirty-six are in operation is a clear indication of the position. The holiday season has further depressed the industry, and, consequently, it is confidently believed that there will be some improvement next month. At present there is a general disinclination to buy, but it is gratifying to note that there is no tendency for the prices of continental material to revert to the low level which prevailed for several years. The acid steel departments in particular are feeling the acute depression, and, in addition, little business is coming from the railway companies which are pursuing a policy of cutting down specifications and suspending or delaying deliveries.

Hollow Steel Forgings.

A speciality of Sheffield manufacturers which is meeting with a fair measure of success is the production of hollow forged drums for high-pressure boilers. The drums have been made up to 20ft. or 25ft. long, with a weight of 20 or more tons, whilst for the air compressor chambers of oil-refining plants, drums up to 40ft. long and 40 tons in weight have been produced. Other drums have been sent out of the country for use in electric power stations. It is also of interest to note that Sheffield firms have applied for patents for the lining of rock boring drills with stainless metal. These drills are used extensively in the South African gold mines, and in their manufacture steel is rolled with a small hole running the whole length of the bar. Through this hole, when the drills are used, flows a constant supply of water which keeps down the dust at the working point and protects the lungs of the miners. A thin tube of stainless metal inside the drill will prevent corrosion by the water.

Engineering Contracts.

The engineering equipment of the new Doncaster Infirmary is to be supplied by the Brightside Foundry and Engineering Company, Ltd., of Sheffield, and although the price of the contract has not been disclosed, it is stated to be one of five figures. The equipment to be supplied includes boiler, calorifiers, feed pumps, central heating, tanks, hot water service, ventilation, cooking apparatus, gas supply plant, sterilising and disinfecting plant, &c. This firm also secured the contract for the heating, ventilation, and hot water systems for a large new co-operative society building in Sheffield, whilst the engineering work for the new medicinal baths at Scarborough is to be undertaken by it. In addition, it has secured the contract for the ventilation and deodorising plants for the new Sheffield Corporation abattoir, in which the system comprises air washing and conditioning apparatus. In this the air is drawn through finely sprayed water, and is afterwards treated by a special system of electrolysis which has the effect of eliminating noxious odours. The treated air is forced through a system of trunking by means of motor-driven fans to all parts of the slaughter-houses and meat markets, thus ensuring the maximum of cleanliness.

Cheaper Electricity.

The decision of the Electric Supply Committee of the Sheffield City Council to recommend a reduction of the prices for electric current to the pre-war level has been welcomed by manufacturers. When the reduction comes into operation, Sheffield will have the benefit of one of the cheapest scales of charges in the country. Councillor E. Snelgrove, Chairman of the Committee, states that the reduction has been made possible by the increased efficiency and output of the electric supply department. Recently the City Council gave sanction to a scheme for additional electricity plant and buildings costing £517,926 at Blackburn Meadows.

Colliery to be Closed.

Owing to the acute depression in the coal trade, the Blidworth Colliery, owned by the Newstead Colliery Company, is to be closed down. This pit was only opened comparatively recently, and it is estimated that approximately £1,000,000 was expended in its construction. In addition, a model village, comprising 830 houses, was erected in the vicinity of the colliery, and although 230 of these houses have not been tenanted, occupants of the village will, of course, be affected by the company's decision. Altogether, 800 men and boys have received notices to terminate their employment on September 8th. This unfortunate position has to some extent been caused by the fact that the colliery has been made the cockpit in the struggle between the Notts. Miners' Industrial Union and the Notts. Miners' Association, the rival bodies. Officials of the Industrial Union claim that if their policy had been acted upon, when they appealed for co-operation with the colliery management, there was a chance that the pit might have continued at work.

Surface Drainage Scheme.

The Ministry of Health has conducted an inquiry into the application of the Nottingham Corporation for sanction to borrow £10,500 to carry out a scheme for surface drainage in the Bulwell district of Nottingham, where serious flooding occurred last winter. It is hoped that this work will be completed before November.

Colliery Seam Reopened.

The Low Main seam of the Birchwood Colliery, Alfreton, has been reopened. It was only a few weeks ago that the colliery was closed on account of the trade depression, but negotiations between the men and the management of the Babbington Coal Company have resulted in the reopening of the seam. In the near future it is hoped to extend the working places, and efforts are to be made to reduce the amount of slack which was formerly sent out of the pit.

L.N.E.R. Main Line Widening.

The work of widening the main line of the London and North-Eastern Railway between Godley and Mottram is being carried out by Messrs. Logan and Hemingway, of Doncaster, the contractors. Including the railway company's commitments outside the contract, the cost of the scheme will probably be between £200,000 and £250,000. The work, which is expected to be completed in about two years, includes the removal of the two Hattersley tunnels, the provision of a public highway bridge over the widened line at Stockport-road, and the wiping out of a large portion of Bottoms Hall Wood.

New Master Cutler.

Mr. Thomas Gilbert Sorby, managing director of Thomas Sorby and Sons, Ltd., iron and steel manufacturers, Sheffield, has been elected Master of the ancient Cutlers' Company of Hallamshire, in succession to Mr. Percy W. Lee, of Arthur Lee and Sons, Ltd., steel manufacturers, Sheffield. The installation ceremony will be on October 2nd. The office of Senior Warden of the Company, vacated by Mr. Sorby, is to be filled by Mr. Arthur K. Wilson, governing director of Spear and Jackson, Ltd., steel manufacturers, of Sheffield.

NORTH OF ENGLAND.

(From our own Correspondent.)

Shipbuilding Activity.

WITH the end of the holiday season, there is reasonable prospect of greater activity in the shipbuilding industry on the North-East Coast generally. A number of orders has been placed during the past few days, while there is a number of inquiries for new tonnage circulating, and altogether the prospects of more work coming to this area are regarded as more encouraging. Swan, Hunter, Wigham-Richardson and Company's Neptune Yard has booked contracts for three vessels for French owners. The most important of the three is a passenger steamer 500ft. in length for the Transport Maritimes of Marseilles, for which company the firm built the "Asina Mendoza" after the war. Another order is for a medium sized passenger steamer with a displacement of about 5000 tons, for the Cie. Générale Transatlantique for service in the Mediterranean. The vessel, which is to be named the "President Dal Piaz," is to be very similar to the "Lamoricière," built by the Tyne firm about seven years ago, and is expected to be delivered next spring, which will mean

considerable effort by the builders. Parsons turbine engines will be installed to give a speed of 15 knots on service, and the vessel will have accommodation for 116 first-class, 164 second-class, 94 third-class, and 300 open-berth passengers. The third vessel ordered is a combined passenger and cargo steamer for the Compagnie Paquet of Marseilles, to be operated on the Morocco line, and the machinery will consist of two triple-expansion engines. Swan, Hunter, Wigham-Richardson have also booked a contract for ten Canadian lake steamers. A few months ago the firm built seven or eight similar vessels in record time—about three months. The work on these vessels will be distributed among firms and shipyards on the Tyne, Wear and Clyde. Another good order is that placed with Sir John Priestman and Co., of Sunderland, to build a superior type of cargo steamer for the Morrison Steamship Company, of Newcastle. The vessel will be of 8000 tons, and her propelling machinery will be built on the Wear by the North-Eastern Marine Engineering Company.

Cleveland Iron Trade.

While resumption of business in the Cleveland pig iron trade after the holidays has not been characterised by any marked accession of activity, there is a slightly better feeling abroad, and traders appear confident that the worst of the depression has been left behind. It is expected that the pig iron industry in this district will benefit as the result of the effects of settlement of the Swedish ore miners' strike. It is assumed that the concessions which have been made to the miners will tend to stiffen the price of ore and so drive up pig iron producers' costs on the Continent. Already foreign pig iron prices are hardening, and pig iron imports into this area have virtually ceased. In most neutral markets the price of Cleveland iron is still not competitive, but a certain amount of it still finds its way abroad, and exports, if they fail to show expansion, are at least maintained. It is, however, in the home market that hopes of improvement are centred, and these hopes have yet to be materialised. Meanwhile, however, prices are very firm, current minimum quotations being :—No. 1 Cleveland foundry, 68s. 6d.; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; and No. 4 forge, 64s. 6d.

Hematite Pig Iron.

In the hematite pig iron trade there is a distinctly better tone. Signs are not lacking that both home and export requirements will be larger, and that stocks will be drawn upon rather extensively in the near future. Already sales are improving and stocks diminishing. Thus, Dorman, Long and Co. have felt justified in restarting an additional hematite furnace at their Newport Works and prices are firmer all round, ranging from 69s. to 70s. for mixed numbers, and 6d. per ton more for No. 1 quality. Hematite is comparatively cheap at 3s. above the fixed price for No. 3 Cleveland, as the pre-war normal difference was 8s. to 10s.

Ironmaking Materials.

Business continues on quiet lines in the foreign ore trade, the settlement of the Swedish ore miners' strike having had no appreciable effect as yet. Merchants, in the confident belief that inadequate supply will force up prices, strongly urge consumers to re-enter the market, but the latter appear as disinclined as ever to enter into new contracts. Best Rubio ore is firm at 22s. 6d. c.i.f. Tees. Blast-furnace coke is in only moderate request. Good medium kinds are freely offered at 17s. 6d. delivered to works in this district.

Manufactured Iron and Steel.

The steelworks are once more in operation after the holidays. In one or two branches of the industry the position is improving, but producers of certain materials still experience considerable difficulty in securing much needed orders. Some departments are fairly well placed as regards contracts on hand, but producers of nearly all commodities would welcome expansion of demand. Semi-finished steel is selling rather better due to somewhat less keen continental competition. The level of prices for foreign products shuts overseas firms out of certain British inland markets. Improvement in demand for finished steel is expected, but as yet buying is quiet. Prices are unchanged.

The Coal Trade.

The Five Counties scheme to help Humber coal exports is severely damaging Northumberland's trade. By the levy on home trade the Humber is picking up more export trade, and there are indications that the four counties outside Yorkshire are benefiting a little by less coal overflowing from the latter county. It is a form of home competition to which Northumberland cannot respond by adopting a similar policy, inasmuch as that county has no home trade worth mentioning, and therefore cannot get help from it whereby it could counter Yorkshire's export prices. By lowering the export price of coal Yorkshire reduces, as Northumberland coalowners point out, the general price of coal exported from this country, and it is enabled to do it because nearly 90 per cent. of its trade is home trade, and thus a levy on this is widespread and substantial. It is therefore assumed that Yorkshire has secured a considerable amount of trade which otherwise might have come to Northumberland. Old contracts at the Northumberland collieries for steam coals are gradually becoming exhausted, and there will be increasing need for fresh business. The current fixed prices, however, are likely to continue, as the collieries are not in any position to make concessions. At the moment there are few indications of any real improvements in the demand. The immediate outlook for several of the steam collieries is rather better, as prompt orders are assuring work for at least a week ahead. Best Northumberland steams are unaltered at 13s. 6d., with secondary qualities quoted at 12s. For gas coals the outlook is disappointing. Orders on hand are few, and despite a good general forward inquiry, definite business is scarce, and consumers are postponing the placing of new business until the tonnage prospects are more dependable. Best qualities are plentiful at 14s. 9d., and secondary kinds at 13s. to 13s. 6d. The home demand for coke remains on the quiet side, but the export trade is only limited by exporters' inability to attract tonnage. Orders on hand are numerous and steadily accumulating, while the forward inquiry generally is maintained. For spot clearances, buyers can cover on favourable terms, but the forward quotations are maintained at fully late prices. Gas coke is 20s. to 20s. 6d.; patent oven cokes, 18s. to 18s. 6d.; beehive and special grades, 22s. to 27s.

SCOTLAND.

(From our own Correspondent.)

Oil from Coal.

JUST recently there has been published the report of developments of an old coal-mining area near Campbeltown, Argyllshire. The fuel, which is plentiful, is practically useless for domestic purposes, but lately it has been found to be rich in oil. After negotiations occupying a considerable period, the coal pit was taken over by an oil trust, which holds the British rights of a German patent of extracting oil from coal, which is claimed to be the cheapest and best-known method. It is said that there are miles of coal seams at places 16ft. thick. It is estimated that the yield of coal will amount to about 70,000,000 tons, giving oil to the value of about 14s. per ton. The development of this industry will be an immense undertaking, as apart from the installation of the necessary machinery, new roads and houses will have to be constructed, and in all probability an addition made to the harbour.

Steel.

There is a more hopeful feeling in the steel trade. Some branches are now comparatively well placed, while others report improvement. Heavy steel has been in better demand, and some establishments are now working full time. Makers of light sheets are steadily employed, and prices are well maintained, but heavy sheets could be much better off. Galvanised sheets are in steady demand. Tube makers are busy in practically all branches. The demand for constructional steel is only moderate.

Iron.

There has been no marked change in the iron trade. Bar iron is depressed and there is no indication of an early improvement. The price is unchanged, however, at £10 5s. per ton, home, and £9 15s. per ton export. On the other hand, re-rolled steel bars are busier, and have bright prospects. They are quoted £7 7s. 6d. to £7 10s. per ton home and £7 5s. per ton export delivery. Pig iron is very dull. Only some twenty-two furnaces are in blast; twelve of which are producing ordinary, eight hematite, and two basic qualities. Prices are nominally unchanged.

Exports and Imports.

During the past week 9800 tons of iron ore, 1300 tons of iron and steel, and 800 tons of pig iron were discharged at Clyde docks. During the same period exports included 3000 tons of iron and steel products and 735 tons of pig iron.

Coal.

General conditions in the Scottish coal trade show little change. Shipping demands continue on a comparatively small scale, but the market is unaffected at the moment, as the bulk of the restricted output is taken up on home account. Within a short period, however, demands on behalf of utility concerns and householders will become more prolific, and in all probability the production will be increased. Meanwhile, practically all descriptions of round coal are moving off steadily on home account. Washed nuts, however, are still very scarce, supplies being difficult to arrange under two to three weeks in some cases. Export business is largely confined to the arranging of deliveries against old contracts. Exporters find difficulty in gaining orders from abroad, buyers being unwilling to pay the prices asked. Aggregate shipments amounted to 229,950 tons, against 232,179 tons in the preceding week, and 211,294 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

SHIPMENTS from this district last week turned out better than expected, as the total amounted to nearly 460,000 tons, as against rather less than 343,000 tons for the previous week. This improvement, however welcome it may be, is much below what is needed, as numerous collieries were idle part of their time for the want of ready tonnage and prompt orders. At the end of last week there were as many as thirty-nine idle tipping appliances at the various docks, but the situation on Monday as the result of week-end arrivals of steamers was that this figure was reduced to seventeen. In these circumstances, there was more loading activity, and certainly a number of the leading colliery undertakings were comfortably off, though this cannot be said to be the case with the majority of concerns. The foreign demand still continues to be comparatively quiet, and, unfortunately, any slight expansion in the inquiry soon appears to fade away. It is not surprising that in the circumstances, values of coals display no particular movement, and remain on the minimum in most instances. Contract operations are almost at a standstill, though it is reported that a Cardiff firm has arranged for the supply of 100,000 tons of coking coals over a period of six months from October next for shipment to Holland. There is also an inquiry on the market for a couple of cargoes of superior large steam coals on Greek Government account. As regards coalfield affairs generally rumour has not been so busy of late on the amalgamation of concerns. Reports of developments have for the moment subsided slightly, but in respect of schemes for the control of the export trade, it was recently reported that a move was on foot for the establishment of a sort of trust for dealing with the whole of the export side of the industry. No definite information is so far forthcoming, but the idea is regarded in coal trade circles as somewhat fantastic.

Docks Traffic.

The Great Western Railway's returns respecting traffic at the six ports under its control in this district for the four weeks ended August 5th, show a total of 2,744,075 tons, which compares with 2,635,408 tons for the corresponding period of last year. The returns are not, however, as good as for the previous month, ending July 8th last, as the total for that period was 2,826,349 tons. The falling off has been due primarily to the decrease in the shipments of coal and coke and patent fuel. Taking the whole of this year from January 1st to August 5th the traffic returns compare very unfavourably with the figures for the same period of last year, as there is a reduction of over 2,000,000 tons, divided fairly evenly between the import and the export sections. The aggregate of imports and exports for this year to August 5th is 21,007,218 tons, as against 23,154,950 tons for the corresponding period of 1927. Coal and coke exports came to 15,936,260 tons, compared with 17,087,954 tons.

Fuel Works Dispute.

At the end of last week an agreement was come to regarding the terms of employment in the case of the men engaged at the Rose Patent Fuel Works at Swansea. These works have been idle pending a settlement being reached. The company proposed a reduction in the tariff, so as to enable the works to operate, and it is understood that the men have agreed to terms involving a 10 per cent reduction, to come into force as from the first Monday in September.

Tin-plate Trade.

Reference was made recently to a contract for a quarter of a million boxes of tin-plates having been placed in this district, but it is now reported that the order of the Asiatic Petroleum Company is for a million boxes, the price being in the neighbourhood of 18s. 9d. per box. Delivery is to be extended over the first half of next year. The contract is to be distributed over various South Wales works, though a quarter of a million boxes will be made at the Elba Works, Swansea, in which the Asiatic Petroleum Company has a substantial interest. The total value of the contract is stated to be over £900,000. Welsh tin-plate makers have decided to increase the official minimum price of tin-plates by 3d. per box, the basis price now being 18s. It is reported that some works have commenced their quarterly compulsory stoppage under the output restriction scheme this week. The stoppage for this quarter is for two weeks.

Current Business.

Operations continue for the most part on the hand-to-mouth principle, but the volume of business is comparatively small, and the tone of the market is quiet. Small coals and sized qualities hold their own, and are far from plentiful, but large coals are freely offered. It is only in exceptional cases, such as a few of the leading descriptions, that stems are at all comfortable, but business is not sufficiently active to enable salesmen to advance their prices above the minima. Patent fuel and coke remain about steady, but orders are wanted. As regards house coals, the group committee concerned has recently had a meeting, and it is understood that the feeling prevailed that prices should be raised. The question will come before the Executive Committee of the Marketing Association early next month.

CONTRACTS.

THE YORKSHIRE COPPER WORKS, Ltd., of Leeds, has received from the Sydney Corporation Electricity Department an order for the cupro-nickel tubes, which after extensive competitive tests with various alloys under actual working conditions at Sydney, it is decided should be used for the Bunnerong power station.

HOWDEN-LJUNGSTROM PREHEATERS (LAND), Ltd., has received from the Leicester Corporation an order for Howden-Ljungström air preheaters to operate in conjunction with four boilers at Freeman's Meadow power station, and for preheaters for pulverised fuel fired boilers now under construction for the new extension to the power station.

THE Great Western Railway officially announces that the following contracts have been placed :—(*a*) Supply of 14-seater body, to be mounted on a six-wheeled Morris chassis—J. Buckingham, Ltd., Birmingham; (*b*) supply, delivery and erection of four electric capstans for The Mole, King's Dock, Swansea—Ransomes and Rapier, Ltd., 32, Victoria-street, S.W. 1; and (*c*) a 50-ton overhead electric travelling crane for Old Oak Common—S. H. Heywood and Co., Ltd., Reddish, near Stockport.

JOSEPH FOSTER AND SONS, of Preston, have recently received the following orders :—(*a*) For a complete power-house installation for the new artificial silk factory now being erected at Stowmarket for the British Acetate Silk Corporation, Ltd.; the order comprises the power-house, eight Lancashire boilers, economisers, stokers, coal conveyors, ash-handling plant, pumps, &c.; (*b*) for boilers, &c., for the extension to the existing power-house of that company; (*c*) for printing machine works at Preston and Blackburn; and (*d*) for driving machinery required for cotton mills in India.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. JAMES LAWSON, who recently resigned his appointment as managing director of E. Cockey and Sons, Ltd., of Frome, Somerset, which post he had held for the last thirteen years, has joined the firm of Bamag-Meguin (G.B.), Ltd., of Broadway-buildings, Westminster, S.W. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/- to 21/-
(1) Spanish	19/- to 21/-
(1) N. African	19/- to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 14 0	—
No. 1 Foundry	3 15 0 to 3 16 0	—
No. 3 Foundry	3 11 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 8 0	3 8 0
No. 1	3 8 6	3 8 6
Cleveland—		
No. 1	3 8 6	3 8 6
Silicious Iron	3 8 6	3 8 6
No. 3 G.M.B.	3 6 0	3 6 0
No. 4 Foundry	3 5 0	3 5 0
No. 4 Forge	3 4 6	3 4 6
Mottled	3 4 0	3 4 0
White	3 4 0	3 4 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 2 6	—
(3) Northampton—		
Foundry No. 3	2 15 0 to 2 17 0	—
Forge	2 13 6	—
(3) Derbyshire—		
No. 3 Foundry	2 19 0 to 3 0 0	—
Forge	2 16 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 0 0	—
No. 4 Forge	2 18 6	—
Basic	2 19 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 2 0 (a) / 4 4 6 (b) / 4 8 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
LANCS.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 10 0	—
MIDLANDS—		
Crown Bars	9 2 6 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 15 0 to 9 0 0	—
Gas Tube Strip	10 15 0 to 10 17 6	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal.Cor. 24 B.G.)	13 12 6	13 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	7 12 6	—
Soft Billets	6 15 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	7 10 0 to 10 0 0	—
MANCHESTER—		
Bars (Round)	8 17 6	—
,, (Small Round)	7 15 0	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
,, (Lancs. Boiler)	9 12 6 to 9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 2 6 and 7 12 6	—
Intermediate Basic	7 0 0	—
Soft Basic	6 5 0 to 6 7 6	—
Hoops	9 0 0	—
Soft Wire Rods	7 5 0 to 7 10 0	—
MIDLANDS—		
Small Rolled Bars	7 7 6 to 8 0 0	—
Billets and Sheet Bars	6 2 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 7 6 to 13 10 0	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	11 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/1½ to 18/3
Block Tin (cash)	210 0 0
,, (three months)	206 15 0
Copper (cash)	62 11 3
,, (three months)	62 18 9
Spanish Lead (cash)	22 0 0
,, (three months)	21 17 6
Spelter (cash)	24 12 6
,, (three months)	24 13 9
MANCHESTER—	
Copper, Best Selected Ingots	67 0 0
,, Electrolytic	69 10 0
,, Strong Sheets	94 0 0
,, Tubes (Basis Price), lb.	0 1 1½
Brass Tubes (Basis Price), lb.	0 1 0
,, Condenser, lb.	0 1 2
Lead, English	23 15 0
,, Foreign	22 5 0
Spelter	25 0 0
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/7 per lb.	
Ferro Tungsten	1/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 10 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£20 10 0	7/-
,, ,, 8 p.c. to 10 p.c. ,,	£20 0 0	6/-
,, ,, Specially refined		
,, ,, Max. 2 p.c. carbon	£33 0 0	12/-
,, ,, ,, 1 p.c. carbon	£38 0 0	15/-
,, ,, ,, 0·70 p.c. carbon	£44 0 0	17/-
,, ,, ,, carbon free	1/1 per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home £13 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 5 0 scale 5/- per unit	
,, ,, 75 p.c.	£19 0 0 scale 6/- per unit	
,, Vanadium	14/3 per lb.	
,, Molybdenum	4/3 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/- per lb.	

FUELS.

SCOTLAND.
(*Prices not stable.*)

	Export
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/9
,, ,, Ell	14/3 to 14/6
,, ,, Splint	16/- to 17/-
,, ,, Trebles	13/3
,, ,, Doubles	13/-
,, ,, Singles	12/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/6
,, ,, Jewel	15/6
,, ,, Trebles	13/6 to 13/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	11/- to 12/9
Screened Navigation	18/-
Trebles	14/- to 14/6
Doubles	13/6 to 13/9
Singles	12/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/3
Secondary Steam	11/9
Trebles	13/6
Doubles	13/3
Singles	12/6

ENGLAND.

(8) N.W. COAST—	
Steams	24/- to 25/-
Household	37/6 to 50/-
Coke	22/6 to 23/6
NORTHUMBERLAND—	
Best Steams	13/3 to 13/6
Second Steams	11/9 to 12/-
Steam Smalls	9/- to 9/6
Unscreened	11/9 to 12/-
Household	21/- to 27/-
DURHAM—	
Best Gas	15/-
Second	13/3 to 13/9
Household	21/- to 27/-
Foundry Coke	18/3 to 19/-
SHEFFIELD—	Inland.
Best Hand-picked Branch	26/- to 27/6 —
Derbyshire Best Bright House	19/6 to 20/6 —
Best House Coal	18/6 to 20/- —
Screened House Coal	16/- to 17/- —
,, ,, Nuts	14/- to 15/6 —
Yorkshire Hards	14/- to 16/- —
Derbyshire Hards	14/- to 16/- —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	5/- to 6/- —
Smalls	3/- to 4/6 —
Blast-furnace Coke (Inland)	13/- at ovens —
Furnace and Foundry Coke (Export), f.o.b.	19/- to 19/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	19/3 to 19/6
Second Smokeless Large	18/- to 19/-
Best Dry Large	17/9 to 18/6
Ordinary Dry Large	17/- to 17/3
Best Black Vein Large	17/6 to 17/9
Western Valley Large	17/- to 17/3
Best Eastern Valley Large	16/6 to 17/-
Ordinary Eastern Valley Large	16/3 to 16/6
Best Steam Smalls	12/6 to 13/-
Ordinary Smalls	10/6 to 12/-
Washed Nuts	16/6 to 19/-
No. 3 Rhondda Large	19/6 to 20/-
,, ,, Smalls	14/- to 14/6
No. 2 ,, Large	16/- to 16/6
,, ,, Through	14/6 to 15/6
,, ,, Smalls	12/6 to 13/6
Foundry Coke (export)	27/- to 36/-
Furnace Coke (export)	19/- to 21/-
Patent Fuel	21/- to 22/-
Pitwood (ex ship)	29/- to 29/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	34/- to 35/-
Seconds	24/6 to 27/-
Red Vein	20/6 to 27/-
Machine-made Cobbles	40/- to 43/-
Nuts	35/- to 43/-
Beans	23/6 to 26/-
Peas	18/- to 19/-
Breaker Duff	8/- to 8/6
Rubbly Culm	12/- to 12/6
Steam Coals:	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	10/- to 12/6
Cargo Through	15/- to 16/-

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield.

(c) Delivered Birmingham. (d) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our own Correspondent in Paris.)

Public Works.

In presenting the Budget estimates for the coming year the Government affirms that it intends to pursue more actively the programme of public works which are regarded as essential to the country's prosperity. The new social legislation has imposed heavier charges all round, but nevertheless Parliament will be asked to vote increased credits for the carrying out of hydro-electric schemes, improvements to ports and a development of military and naval aviation. It is asserted that no further burdens will be placed upon industry, to which it is hoped to grant some relief by the distribution of cheap energy from the sources of hydraulic supply, and the Government has practically committed itself to the more general utilisation of hydraulic resources, particularly in the interests of the agricultural industry, which is to benefit from rural electrification and irrigation. Although the carrying out of the electrification scheme is encouraged, it is argued that the high rate of interest on capital may make it difficult for hydro-electrical undertakings to pay their way, and it is supposed that there will eventually be a merging of companies into a few big groups. The history of the hydro-electrical enterprises will be similar to that of the early history of the railway companies. The increased credits which it is proposed to ask for the ports will allow of still more being done in the way of harbour extensions and equipments, particularly at Havre, Bordeaux and Marseilles. The work already accomplished at nearly all the ports in order to permit the berthing of larger ships and facilitate loading and unloading is remarkable. At Rouen another floating dock of 6000 tons has just been delivered by Germany on account of reparations. Parliament will also be invited to vote additional credits for the inland waterways, particularly the Moselle between Metz and Thionville. A particularly large increase in credits is asked for the naval flying service, which is to be organised upon a much more extensive scale. This is only a part of what it is proposed to do at home and in the colonies, and it is clear that the whole programme could not be carried out without the aid of German reparations, which are to be utilised to the value of 1200 million francs. This naturally does not afford unalloyed satisfaction to home manufacturers, who will not derive so much benefit from the programme of public works as would seem to be justified by its importance; but they will certainly secure quite a large share of the business, certainly more than one-half, and it is expected that the carrying out of the programme will help to give some stability to the manufacturing industries in the coming year.

Steamer's Air Service.

The Transatlantic steamer "Ile de France" was equipped before starting on her last voyage with a platform for a specially designed Lioré and Olivier machine designed for floating and for landing and fitted with an engine of 420 horse-power, which would take the mails from the ship before arriving at the port. The operation was carried out successfully when nearing New York, and on the return journey the aeroplane took off from the ship at 150 miles from the Scilly Isles. Four and a-half hours later the machine reached Cherbourg, when it took in a supply of fuel and then continued to Le Bourget, near Paris, which it reached in 7 hours 50 minutes after leaving the ship. The mails were distributed twenty-four hours sooner than it would have been possible by the ordinary means.

Colonial Railways.

The laying down of railways in the colonies is largely determined by strategical reasons, and efforts are then made to utilise them for the economical development of the country. They do not always give the results expected of them, as seems clear from the criticisms that are being made of the efforts to develop the Niger Valley with the aid of a railway which was originally constructed for a strategical purpose. The colonial interests, supported by the Chambers of Commerce and other commercial associations, support every railway scheme under the impression that it is bound to open up the country and create traffic, and the possibility of the Niger Valley producing as much cotton and other produce as may be required for the home industries has become an obsession. In Africa, apparently, the situation is not looked upon in the same light, for there is a certain amount of opposition to the Niger Valley scheme on the ground that the Kayes-Thiès Railway does not offer an economical means of transport and that the carriage of raw material to the coast would be far too heavy. This criticism, it seems, is intended to draw attention to the supposed superior advantages of the Senegal Valley, which, it is declared, could produce as much cotton and other raw material as the Niger Valley, and it would have the advantage of much cheaper transport to the coast. The difficulty of communication with the Niger Valley is, in fact, recognised, and it is for that reason that it is proposed to construct the Transsaharan Railway. This again is mainly strategical and, on account of the cost, it obviously cannot be undertaken unless it is certain that the traffic from the regions to the south of the desert will be sufficiently remunerative. In a word, it is found that military reasons cannot be allowed to exercise an undue influence upon the construction of railways in the colonies.

Foreign Trade.

The object of the French fiscal policy has been for a considerable time past to develop the home manufacturing industries, and then to provide facilities for an export trade, but the monthly returns show that, while one part of the programme is having fairly successful results, chiefly on account of the activity displayed in carrying out public works at home and in the colonies, the efforts to stimulate trade abroad have failed, so far at least as values are concerned. The exports of "material necessary for industry," for instance, increased by 1,627,887 tons and the value declined by no less than 2409 million francs. This applies mainly to iron and steel. It is reported that motor car firms have recently placed orders for British machine tools to the value of a million francs.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

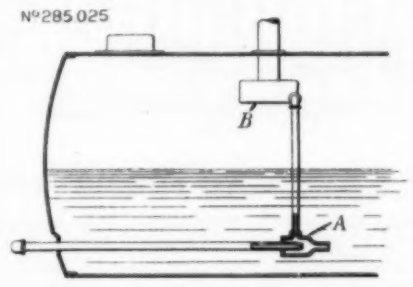
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

285,025. January 2nd, 1928.—STEAM SEPARATORS, J. Gordon and Co., Ltd., Windsor House, Kingsway, London, W.C. 2.

This device is intended to ensure that the separator in the steam pipe of a boiler shall be kept free of separated water. It is pointed out that such separators are generally drained by



gravity, but that the difference in head is insufficient to keep the separator clear if the boiler is steaming hard. The inventors consequently use an ejector A to suck the water out of the separator B. This ejector is worked by the feed water and consequently keeps pace with the duty demanded from the boiler.—*July 26th*, 1928.

DYNAMOS AND MOTORS.

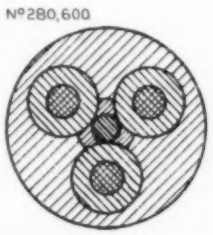
294,429. December 20th, 1927.—IMPROVEMENTS IN STARTING ARRANGEMENTS FOR SYNCHRONOUS CONVERTERS, Allmänna Svenska Elektriska Aktiebolaget, of Västeras, Sweden.

This invention relates to starting means for synchronous converters, particularly for converting alternating current to continuous current. A starting motor of the induction type is connected to the converter, the motor having two secondary windings, one of which is permanently short-circuited, while the other is connected to slip rings, so that a continuous current can be introduced therein, when the motor has reached nearly synchronous speed, and the pulling into synchronism is thereby effected. The permanently short-circuited winding may have a high ohmic resistance and comparatively low leakage inductance so as to give a high starting torque. The other winding is short-circuited during the speeding up period for reducing the total ohmic resistance and thereby the slip so as to facilitate pulling into synchronism. If the second winding is short-circuited during the entire speeding up starting period it has preferably a lower ohmic resistance but higher leakage inductance than the first-mentioned winding; for example, it may be placed at a comparatively large depth in the rotor slots. The second winding is preferably a three-phase winding with the terminals of two of its phases permanently connected together and to a common slip ring, while the terminal of the third phase winding is connected to the other slip ring. The two slip rings or corresponding terminals are directly connected together so as to short-circuit the three-phase winding during the starting operation until nearly synchronous speed has been reached. The slip rings are then disconnected from each other and connected to a continuous current source, which for machines converting alternating current into continuous current may preferably be the continuous-current side of this machine, so as to excite the rotor and pull it into synchronism, the right polarity of the synchronous converter being then automatically attained.—*July 26th*, 1928.

TRANSMISSION OF POWER.

280,600. November 14th, 1927.—AN IMPROVED METHOD OF MANUFACTURING RUBBER-COVERED CABLES FOR THE TRANSMISSION OF ELECTRIC POWER, Felten & Guilleaume Carlswerk Actien-Gesellschaft, of Köln-Mülheim, Germany.

This invention relates to a method of manufacturing three or multi-wire rubber-covered cables for the transmission of electric power, which contain a supporting strand; for instance, a steel strand for increasing the resistance of the cable to pulling forces. Soft rubber is first of all pressed round the steel core and over the strand thus covered the rubber insulated individual cores are stranded together as usual, viz., with a pitch ten to twelve times the outer diameter of the stranded cores. By

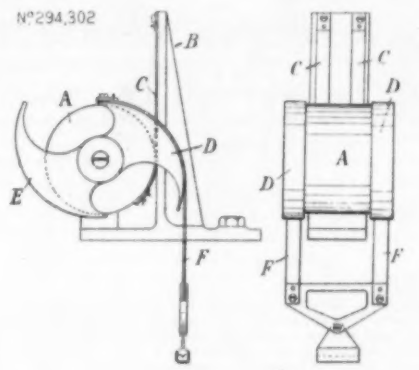


proceeding in this way the rubber placed around the steel strand is pinched in the spaces between the cores, so that the latter come to lie at equal distances from one another. After the stranding an outer common cover of rubber is provided and the cable is vulcanised. In this way a cable is obtained which has the cross section illustrated. The same method can be advantageously employed when it is desired to strand together four or more cores around a steel strand. The method, the specification states, is of great importance, especially in the case of three-wire cables, since in this case the tendency of the cores to become displaced towards one side is especially great when use is made of thick steel cores and the usual stranding.—*July 26th*, 1928.

MEASURING AND TESTING INSTRUMENTS.

294,302. May 5th, 1927.—WEIGHING MACHINES, D. Lowe, jun., 7, Kirkwood-place, Edinburgh; and J. W. Wheeler, 76c, Inveresk-road, Musselburgh.

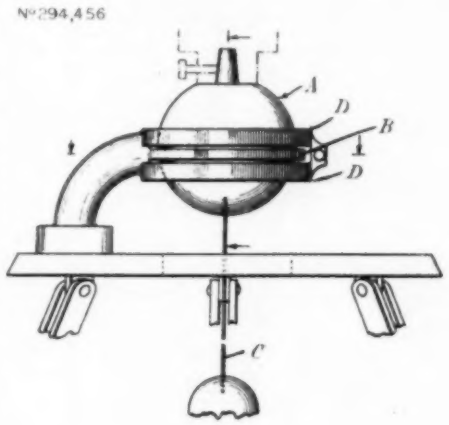
The scale over which the pointer of this weighing machine moves has equal divisions, while it is said to be insensitive to small variations from a level position. It comprises a roller-shaped weight A hung from a bracket B by two ribbons C C,



which are attached to its periphery. At either end of the weight there are two pairs of cams D D and E E. The cams E E are merely for the purpose of counterbalancing D D. Wrapped round the cams D D there are two ribbons F F, which carry the load to be weighed. It will be seen that according to the load to be weighed the weight A will be raised and that a pointer actuated from its axis will give a measure of that weight.—*July 26th*, 1928.

294,456. March 10th, 1928.—LEVELLING DEVICES, *E. C. R. Marks*, 57, *Lincoln's Inn-fields, London, W.C. 2.*

For the purpose of levelling such instruments as theodolites the inventor mounts the instrument, the base of which is indicated by dotted lines, on a ball A. This ball is supported in a

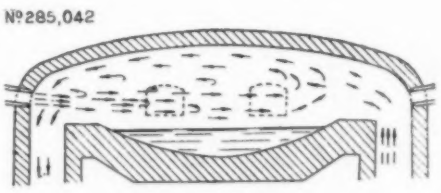


ring B by means of ball bearings. Beneath the ball A there is a rod C, which carries a plumb bob, that ensures the instrument being properly levelled. When this is done the two clamping rings D D are tightened up.—*July 26th*, 1928.

FURNACES.

285,042. February 9th, 1928.—PULVERISED FUEL FURNACES, Witkowitzer Bergbau-und Eisenhütten-Gewerkschaft, 10, Moravska ostrava, Witkowitz zelezarny, Czecho-Slovakia; and C. Salat, 8, Republikstrasse, Witkowitz, Czecho-Slovakia.

It is claimed that by adopting this system of pulverised coal firing the fuel consumption of a regenerative open-hearth furnace can be reduced by 50 per cent. The powdered coal, with its



primary air, is injected over the hearth at such a velocity that the heavier particles reach the distant side if they are not consumed beforehand. There they settle on the bath and are consumed by the secondary air flowing in on the opposite side. The velocity of the secondary air is low, but it makes the flame double back on itself, as shown by the arrows. The flows are, of course, reversible on the regenerative principle.—*July 26th*, 1928.

MISCELLANEOUS.

279,842. October 24th, 1927.—METHOD AND ARRANGEMENT FOR OBTAINING A PERFECT HIGH VACUUM IN ELECTRIC DISCHARGE TUBES, Dr. Siegmund Loewe, of 5, Niedstrasse, Berlin-Friedenau, Germany.

Experiments have shown that the usual method of producing a high vacuum in valves by dispersing magnesium will only permit the desired result to be approximately attained in favourable circumstances. According to this invention, the piece of magnesium A to be dispersed is provided as a plate or ring and is of such size and shape that, on being exposed to a sufficiently strong eddy current field, it may be made to glow and disperse. The piece of magnesium A is some distance from the anode B in order that it may be heated and glowed separately from, and independently of the anode. The coil used for glowing is shown

in cross section and indicated by C. It is connected in the usual manner in a high-frequency oscillatory circuit. In the position illustrated the piece of magnesium A is mainly exposed to the eddy currents. If the coil is moved further down, for example, into the position E indicated by dotted lines, the electrode system B will be mainly traversed by eddy currents so that it is made to

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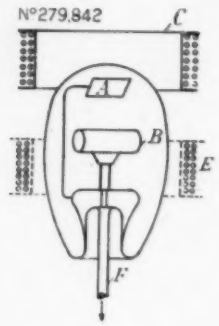

glow. Thus, simply by lifting the coil it is possible first to extract the gases from the system B, then from the magnesium piece A. The gases evolved during the extraction of gas from the magnesium and the system elements are conducted to the pump through the pump socket F. A special advantage of the process is that, for dispersing the magnesium, the anode B need not glow, but may be comparatively cold.—*July 26th*, 1928.

281,734. November 25th, 1927.—Improvements in High-tension Electric Insulating Bushings, Quartz and Silice, of 5, rue Cambacérès, Paris (8), France.

An insulating bushing constructed in accordance with this invention consists of a block of fused silica A with a channel B for the conductor C that has to be insulated. The wall of the block A is metallised as also is the supporting base of the

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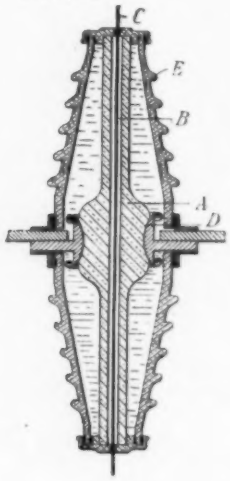

metal collar D dividing the lines of force in the electrical field. The element formed by the block A and its collar is immersed in oil in the casing E, which may be made of glass, porcelain or other insulating material, and it may be made in one or several pieces, as illustrated. Several advantages are claimed for this form of construction, one being that solid insulation may be used instead of oil.—*July 26th*, 1928.

294,343. June 10th, 1927.—Chain Shackles, Marine and Factory Suppliers, Ltd., and W. Stevenson, Cunard Buildings, Liverpool.

The inventors state that in service the legs of chain shackles

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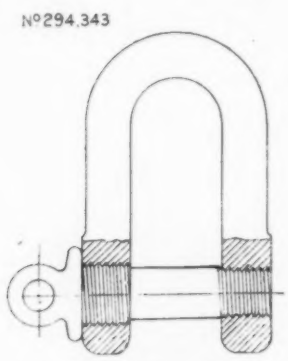

tend to become squeezed together and it is then difficult or impossible to remove the pin. They consequently thread the pin at both ends, as shown, the two threads being of different diameters to facilitate insertion and removal.—*July 26th*, 1928.

294,452. February 22nd, 1928.—Improvements in Resistance Grids for Electrical Purposes, Crompton Parkinson, Ltd., of Salisbury House, London-wall; and George Page, of Arc Works, Chelmsford, Essex.

In a metal sheet or plate slits A are formed by stamping or cutting. The slits extend from opposite edges alternately so that a number of strips B is formed. The metal uniting each pair of strips is subjected to a stamping or pressing operation which draws up or shortens the metal and results in the formation of a boss or projection C which may be of any convenient shape. The stamping or pressing operation is such that adjacent bosses or projections C on each edge or side of the grid extend in opposite directions. The drawing up or shortening of the metal due to the formation of the bosses C causes the opening of each of the slits A into a V shape. The grid so formed has rigidity imparted to it by a strip of insulated metal D which is folded over the edges of the grid and pressed into contact with it. The metal capping

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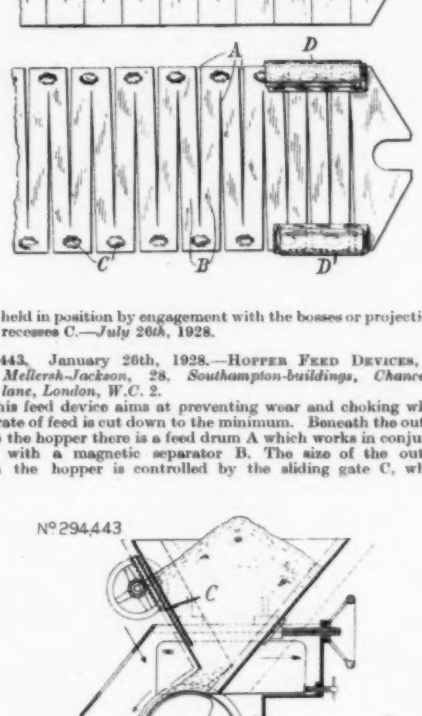

D is held in position by engagement with the bosses or projections and recesses C.—*July 26th*, 1928.

294,443. January 26th, 1928.—Hopper Feed Devices, *L. Mellersh-Jackson, 28, Southampton-buildings, Chancery-lane, London, W.C. 2.*

This feed device aims at preventing wear and choking when the rate of feed is cut down to the minimum. Beneath the outlet from the hopper there is a feed drum A which works in conjunction with a magnetic separator B. The size of the outlet from the hopper is controlled by the sliding gate C, while

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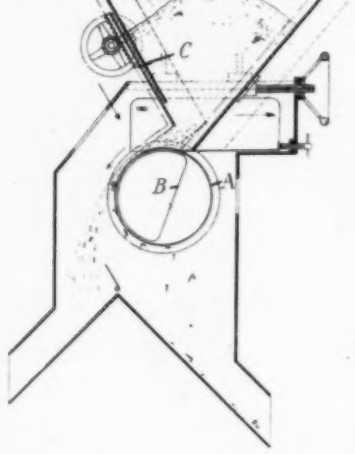

the whole hopper can be traversed, with respect to the roll, by the screw gear shown on the right. It will be seen that, regardless of the size of the opening left by the gate C, the relative positions of the hopper and feed drum can be so arranged that the angle of repose of the material prevents its discharge until the drum is turned. The distance of a tangent to the drum from the bottom lip of the gate is a measure of the rate of flow, rather than the total area of the opening of the gate.—*July 26th*, 1928.

290,298. May 11th, 1928.—Improvements relating to the Synchronisation of Electrical Devices, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

It is frequently desirable to establish and maintain a predetermined relation between the electrical conditions of devices

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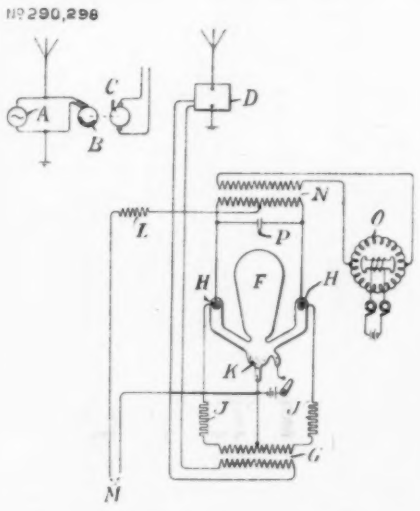

by means of current transmitted through space. In the operation of radio television systems, for example, it is necessary both that a predetermined relation be maintained between the frequencies of the transmitting and receiving apparatus and that this relation be maintained by means of current transmitted through space. The transmitting apparatus comprises an antenna connected to a high frequency current source A and to a commutator B which is arranged to be driven by a machine C at a speed dependent on the operating frequency of the transmitting apparatus. Under these conditions the high frequency carrier current supplied by the source A is modulated in accordance with the frequency of the transmitting apparatus. Parts of the transmitting apparatus that are not essential to an understanding of the invention have been omitted. The receiving apparatus comprises an antenna, a receiving device D, and a vapour electric device F, which is arranged to have the potential of its grids H controlled by energy supplied through the antenna, the receiving device D and a grid transformer G. The transformer G is provided with secondary end terminals connected to the grids H through resistors J and by an intermediate terminal is connected to the cathode K. The device F has a pair of anodes which are connected to the end terminals of the transformer N and the cathode K is connected through a smoothing reactor L, leads M, and a direct-current source. Current is supplied from the transformer N to a synchronous machine O, which may be utilised to drive certain parts of the receiving apparatus. A capacity P is connected between the anodes for ensuring the proper transfer of current from one anode to another. The frequency of the potential applied to the grids H is controlled in accordance with the operation of the commutator B and power is transmitted through the leads M, the device F, and the transformer N to the machine O at a frequency which is always determined by the operating frequency of the transmitting apparatus. The system has the advantage that large amounts of power may be controlled without connections between the transmitting and receiving apparatus and without the use of moving contacts.—*July 26th*, 1928.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TUESDAY TO FRIDAY, SEPTEMBER 4TH TO 7TH.

The Institute of Metals.—Annual autumn meetings at Liverpool. For programme see page 129, August 3rd.

WEDNESDAY, SEPTEMBER 5TH, TO SATURDAY, SEPTEMBER 22ND.

The Fourth Machine Tool and Engineering Exhibition, at Olympia.

THURSDAY AND FRIDAY, SEPTEMBER 6TH AND 7TH.

North British Association of Gas Managers.—Annual general meeting in the Masonic Hall, George-street, Edinburgh. 10 a.m., discussion upon Mr. R. M. Simpson's paper, "Lands Valuation and Income Tax Charges;" William Young Memorial Lecture, by Dr. Charles Carpenter, C.B.E., London. 2.30 p.m., paper by Mr. George Braidwood, Coatbridge, "Quality." The Lord Provost, Magistrates, and Councillors of the City of Edinburgh invite the members and friends to a reception in the City Chambers, on Thursday, September 6th, at 8 p.m. The excursion on September 7th will be by train to Melrose, leaving Edinburgh (Waverley Station) at 10.10 a.m.

SATURDAY, SEPTEMBER 8TH.

Belfast Association of Engineers.—Visit to Dundalk to inspect the locomotive works of the Great Northern Railway Company. Leave Belfast at 2.30 p.m.

The Institution of Municipal and County Engineers.—Town Hall, Great Yarmouth. Eastern District meeting. 11 a.m.

Institution of Municipal and County Engineers.—Town Hall, Morpeth. North-Eastern District. 2 p.m.

THURSDAY AND FRIDAY, SEPTEMBER 13TH AND 14TH.

The Ceramic Society: Refractory Materials Section.—The Societies' Room in the Royal Technical College, George-street, Glasgow. Papers: "Refractories for Electric Elements," by Mr. P. Cooper; "Notes on Refractories for Salt Glazed Kilns," by Mr. W. Emery; "Drying Cracks," by Mr. C. E. Moore; "The Functions of Regenerators in Relation to the Properties of the Refractories of Construction," by Mr. A. T. Green; "A Comparison of the Properties and Industrial Durability of Lime-bonded and Clay-bonded Silica Bricks," by Mr. W. J. Rees; and "The Dissociation of Carbon Monoxide in Contact with Fire-clays and Silica," by Messrs. W. J. Rees and D. W. Hubbard. At 10.30 a.m. each day.

SATURDAY, SEPTEMBER 15TH.

Institute of British Foundrymen: Lancashire Branch.—Visit to the locomotive works of the Vulcan Foundry, Ltd., Newton-le-Willows. Train leaves Exchange Station, Manchester, at 8.55 a.m.

Institution of Municipal and County Engineers.—Town Hall, Swanage. South-Western District meeting. 11.30 a.m.

TUESDAY AND WEDNESDAY, SEPTEMBER 25TH AND 26TH.

Iron and Steel Institute—Autumn meeting in Bilbao, Spain. For programme see page 209, August 24th. 10 a.m. each morning.

LAUNCHES AND TRIAL TRIPS.

Alpharot, cargo steamer; built by Wm. Gray and Co., Ltd., to the order of Van Nievolt, Gordriaan and Co.'s Stoomvaart Maatschappij, Rotterdam; dimensions, 423ft. 7in. by 56ft. 2½in. by 29ft. 6in. Engines, triple-expansion, 27in., 43in. and 73in. by 51in. stroke, pressure 200 lb. per square inch; constructed by Central Marine Engine Works of the builders; successful sea trials were run on August 24th.

Pato Real, motor tug; built by John I. Thornycroft and Co., Ltd., to the order of Forestal Land, Timber and Railway Company, Ltd., Buenos Aires; dimensions, 50ft. by 13ft. 6in. by 6ft. Engines, Bolinder two-cylinder; a speed of over 9¼ knots was attained on trial trip, August 27th.

The Institution of Electrical Engineers.—We are asked by the Secretary of the Institution of Electrical Engineers to announce that on and after Monday, September 3rd, 1928, the Institution's telephone number will be Temple Bar 7676.